National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
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COMPUTER PROGRAM DOCUMENTATION
MODIFIED VERSION OF THE
JA70 AERODYNAMIC HEATING COMPUTER PROGRAM H800 (MINIVER)
WITH A DISSPLA PLOT PACKAGE

Job Order 52-309

CPD-919

Prepared By

Lockheed Engineering and Management Services Co., Inc.
Houston Division
Houston, Texas

Contract NAS 9-15800

For

STRUCTURES AND MECHANICS DIVISION
THERMAL TECHNOLOGY BRANCH

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

March 1980

LEMSCO-14571

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ACKNOWLEDGEMENT

The writer of this manual wishes to express his appreciation to S. J. Damico of Lockheed for his valuable cooperation in helping solve DISSPLA problems.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
JSC-16500		

4. Title and Subtitle	5. Report Date
Modified Version of the JA70 Aerodynamic Heating Computer Program H800 (MINIVER) With a DISSPLA Plot Package	March 1980
	6. Performing Organization Code: 625-51

7. Author(s)	8. Performing Organization Report No.
L. Olmedo Lockheed Engineering and Management Services Co., Inc.	LEMSCO-14571
	10. Work Unit No.: 63-2135-2309
9. Performing Organization Name and Address Lockheed Engineering and Management Services Co., Inc. 1830 NASA Road 1 Houston, Texas 77058 Technical Monitor: R. G. Brown	11. Contract or Grant No.: NAS 9-15800
	13. Type of Report and Period Covered: Computer Program
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Lyndon B. Johnson Space Center Houston, Texas 77058	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This document describes changes, modifications, and additions to the MINIVER computer program, an automated method of aerodynamic heating.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
DISSPLA	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	218	

*For sale by the National Technical Information Service, Springfield, Virginia 22161

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1. INTRODUCTION

The MINIVER computer program (ref. 1) is an automated method of using the simplistic approach to aerodynamic heating. Prime benefits from using MINIVER computer code are the flexibility and economy resulting from the use of a point solution technique. This document describes the changes, modifications, and inclusions which have been adapted to the current version of the MINIVER program. Extensive modifications were made to various subroutines, and a complete new plot package added. This plot package is the Johnson Space Center DISSPLA Graphics System currently driven under an 1110 EXEC 8 configuration. This document provides user instructions on executing the MINIVER program, gives a detailed description of the changes and modifications made, and provides an extensive description of the plot package.

2. DISCUSSION

The version of MINIVER which was modified used the cumbersome method of allowing data to be input by use of a data editor subroutine recognizing location numbers, rather than conventional input techniques. As a result, any increase in size of an input array resulted in failure to execute the program. For this reason, the input data method was changed and will be handled by FORTRAN NAMELIST.

The old subroutines INPUT and INPUTA were completely removed, eliminating the need for storing all of the input data within an array called W with fixed 1500-computer word locations. The user is now free to change array sizes of the input parameters, with little or no impact in the editing and execution of the program.

The main subroutine (H800) was extensively modified to handle storing of generated data in an 1110 UNIVAC-secured file, and a subroutine called STORED was written to handle this task. The contents of this secured file can be retrieved later for plotting purposes.

The printed output was handled by the main program H800; this method was also changed. A subroutine called NEWOUT was written to allow the main program to be almost output free.

The subroutine WRINP, which also handles the printing of input data, was rewritten to accommodate the changes made with the inclusion of the new input technique.

Another subroutine changed was SETMUP. This routine sets up thick-skin parameters and writes out the input.

Changes in subroutines TRANS and OPTMYZ were minor and are indicated through comments cards within the program listing.

Once calculations for a body point have been completed, the user has the option of plotting the generated data or storing it for later processing. A routine to perform this task was written, and a complete description is given in section 10 of this manual. The main program makes a call to the routine which drives the plot package.

3. INPUT DESCRIPTION

MINIVER input is basically the same as before modification, but the method of getting the data in the program has been changed. The old method used the ENCODE, DECODE technique; the new version uses FORTRAN NAMELIST. The computer name for NAMELIST is DATALO.

Table I shows the input parameters by group, with units and symbols. Two new columns have been added: program name (the name used in the program) and array size (the number of computer words currently assigned to that particular parameter). The array size is assumed to be a single value when none is shown.

Table II shows the new parameters introduced into the modified version, not classified under groups or symbols.

TABLE I. - INPUT PARAMETERS BY GROUP

Symbol	Program name	Parameter	Units	Array size
		Timing decisions		
t_1	T1	Initial time	sec	
Δt_1	DT1	Printout interval 1	sec	
t_2	T2	Second time	sec	
Δt_2	DT2	Printout interval 2	sec	
t_3	T3	Third time	sec	
Δt_3	DT3	Printout interval 3	sec	
t_4	T4	Fourth time	sec	
K_{calc}	DTCALC	Calculation interval factor		
ΔT_{max}	DTEMAX	Maximum temperature rise per iteration	^{o}F	
CONT (flag)	CONFLG	Continuity option flag		
		Freestream definition		
ATM (flag)	ATFLAG	Atmosphere/freestream flag		
N_t	ENTR	Number of time-dependent table entries		

TABLE I. - Continued

Symbol	Program name	Parameter	Units	Array size
		Freestream definition (continued)		
t_z	TZ	Table of times	sec	50
Z_∞	ZZ	Table of altitudes	ft	50
V_∞	VZ	Table of freestream velocities	ft/sec	50
NF (flag)	NFF			
Z_A	ALFAOT	Table of atmosphere table altitudes	ft	50
T_∞	DELTAT	Table of freestream temperatures	^oR	50
P_∞	FSPRES	Table of freesteam pressures	lbf/ft^2	50
ARIDE (flag)	ARIDEF	Freestream flag		
		Flowfield definition		
FF (flag)	GF	Flowfield flags 1-6		6
	HH	Flowfield flags 7-9		3
FF }	ANGLE	Flowfield angles 1-9	deg	10
N_{FF}	ENT1	Number of FF } table entries		

TABLE I. - Continued

Symbol	Program name	Parameter	Units	Array size
		Flowfield definition (continued)		
t_{FF}	TA	Table of FF ⟩ table times	sec	10
FF ⟩ 1	A1	Table of FF ⟩ 1's	deg	10
FF ⟩ 2	A2	Table of FF ⟩ 2's	deg	10
FF ⟩ 3	A3	Table of FF ⟩ 3's	deg	10
FF ⟩ 4	A4	Table of FF ⟩ 4's	deg	10
FF ⟩ 5	A5	Table of FF ⟩ 5's	deg	10
FF ⟩ 6	A6	Table of FF ⟩ 6's	deg	10
FF ⟩ 7	A7	Table of FF ⟩ 7's	deg	10
FF ⟩ 8	A8	Table of FF ⟩ 8's	deg	10
FF ⟩ 9	A9	Table of FF ⟩ 9's	deg	10
		Crossflow definition		
CF (flag)	CFFLG	Crossflow option flag		
D_o	DSUBO	Rectangle width	ft	
λ	ELMBDA	Delta wing sweep angle	deg	
$\dot{u}$	UDOT	Real gas velocity gradient factor		

TABLE I. - Continued

Symbol	Program name	Parameter	Units	Array size
		Crossflow definition (continued)		
R_c	CORNR	Rectangle corner radius	ft	
TRT (flag)	ATRE	QRAD TR flag		
		Heat transfer		
HT (flag)	HTFLG	Heat transfer method option flag		
N_L	ENL	Laminar mangler transform factor		
N_T	ENT	Turbulent mangler transform factor		
R_N	RN	Nose or leading edge radius	ft	
L	EL	Running length	ft	
ϕ	PHI	Local slope or sweep angle	deg	
N_G	ENT3	Number of geometry table entries		
t_G	TMZ	Table of geometry table times	sec	
R_{N_G}	RNZ	Table of nose radii	ft	10
L_G	ELZ	Table of running lengths	ft	10

TABLE 1. - Continued

Symbol	Program name	Parameter	Units	Array size
		Heat transfer (continued)		
Φ_G	PHIZ	Table of local slopes or sweep angles	deg	10
$\mathfrak{F}_G$	EMIZ	Table of view factors		10
VRL (flag)	VRFLG	Virtual running length option flag		
ReA (flag)	RANFLG	Von Karman-Reynolds analogy flag		
		Transition definition		
TRANS (flag)	TRFLAG	Transition option flag		
PARA I	PARA1	Initial or onset parameter		
PARA II	PARA2	Final or fully turbulent parameter		
K_{EXTENT}	ELFAC	Extent-of-transition length ratio		
	ARIT			
	HFAC	q/q factor		

TABLE I. - Continued

Symbol	Program name	Parameter	Units	Array size
		Heat transfer multiplier definition (continued)		
K_{L_3}	AKL3	Table of Mach-dependent laminor multipliers		10
K_{T_3}	AKT3	Table of Mach-dependent turbulent multipliers		10
	HFACT			10
		Material definition		
MATL (flag	EMATL	Material type option flag		
Δ_m	DEL	Material thickness	in.	
ϵ	EMIS	Emissivity		
		Thin skin inputs		
T_{INIT}	TIN	Initial temperature	^oF	
ρ_m	RHOM	Input material density	lbm/ft^3	

TABLE I. - Continued

Symbol	Program name	Parameter	Units	Array size
		Thin skin inputs (continued)		
C_{p_m}	CPM	Input constant specific heat	Btu/lbm^{o}R	
N_{mz}	ENMTL	Number of specific heat table entries		
T_{mz}	TMAT	Table of specific heat table temperatures	^{o}F	10
Cp_{mz}	CPMAT	Table of specific heats	Btu/lbm^{o}R	10
		Optimization		
OPT (flag)	IOPT	Optimization flag		
Topt	TOPT	Optimization temperature	^{o}F	
β	PERCNT	Accuracy criteria		
		Miscellaneous		
ENVIR (flag)	ENVIR	Environment summary printout flag		

TABLE I. - Continued

Symbol	Program name	Parameter	Units	Array size
		Thick skin option		
N_{nodes}	NODES	Number of nodes (2 to 25)		
Δ_m	DX	Node thicknesses	in.	25
T_i	T	Initial temperatures	^oF	25
MATL (flag)	MPFLAG	Node material code		25
ρ_m	RHOZ	Node densities	lb_m/ft^3	25
Cp_m	CPZ	Node specific heats	Btu/sec ft^o F	25
K_m	CONDZ	Node conductivity	Btu/sec ft^o F	
N_{mte_1}	NTAB1	Number of entries in 1st material properties		
T_1	TABT1	First table of temperatures	^oF	10
Cp_1	TABCP1	First table of specific heats	Btu/lb_msec^o F	10
K_1	TABCX1	First table of conductivity	Btu/ft sec^o F	10

TABLE I. ıtinued

Symbol	Program name		Units	Array size
N_{mte_2}	NTAB2	Number of entries in 2nd material properties		
T_2	TABT2	Second table of temperatures	^{o}F	10
Cp_2	TABCP2	Second table of specific heats	$Btu/lb_m sec^{o} F$	10
K_2	TABCX2	Second table of conductivity	$Btu/ft\ sec^{o} F$	10
N_{mte_3}	NTAB3	Number of entries in 3rd material properties		
T_3	TABT3	Third table of temperatures	^{o}F	10
Cp_3	TABCP3	Third table of specific heats	$Btu/lb_m sec^{o} F$	10
K_3	TABCX3	Third table of conductivity	$Btu/ft\ sec^{o} F$	10
N_{mte_4}	NTAB4	Number of entries in 4th material properties		
T_4	TABT4	Fourth table of temperatures	^{o}F	10
Cp_4	TABCP4	Fourth table of specific heats	$Btu/_m sec^{o} F$	10
K_4	TABCX4	Fourth table of conductivity	$Btu/ft\ sec^{o} F$	10
N_{mte_5}	NTAB5	Number of entries in 5th material properties		
T_5	TABT5	Fifth table of temperatures	^{o}F	10
Cp_5	TABCP5	Fifth table of specific heats	$Btu/lb_m sec^{o} F$	10
K_1	TABCX5	Fifth table of conductivity	$Btu/lb\ sec^{o} F$	10

TABLE I. - Concluded

Symbol	Program name	Parameter	Units	Array size
		Thick skin option (continued)		
T_{sink}	TSINK	Inner wall sink temperature	^{o}F	
$\mathfrak{F}_{IW}$	FIW	Inner wall shape factor (εF)		
h_{IW}	HCIW	Inner wall heat transfer coefficient	$Btu/ft^2sec\ ^{o}F$	
T_{Gas}	TGAS	Inner wall gas temperature	^{o}F	
N_{IW}	NTIWZ	Inner wall environment table entries		50
t_{IWZ}	TIWZ	Environment table times	sec	50
h_{IWZ}	HCIWZ	Heat transfer coefficient table	$Btu/ft^2sec\ ^{o}F$	50
T_{GasZ}	TGASZ	Gas temperature table	$Btu/ft^2sec\ ^{o}F$	50
T_{SINKZ}	TSINKZ	Inner wall sink temperature table	^{o}F	50

TABLE II. - NEW INPUT PARAMETERS

Program name	Description	Array size
ICASE	Case number	
LNGPLT	Flag used for plotting. >0 long plots <0 short plots	
IHCOPY	Flag used for plotting. >0 no plot generation <0 make plots	
IPLTWE	Flag used for plotting while in Demand mode. >0 plot while on Demand <0 no plot	
IFLGOT	Flag used for printed output while on Demand mode. >0 print output data <0 no print	
BDYPNT	Body point ID. (Alpha input, 24 characters)	4
TRANME	Trajectory ID. (Alpha input, 36 characters)	6
IBPNUM	Body point number	
MAXTME	Max time used per run (in seconds)	

4. PROGRAM EXECUTION

There are several ways to execute MINIVER; the most convenient is in demand mode. Upon sign-on, type on device:

@START ES35-NO6516*LOREN.RUNMIN

Contents of RUNMIN, including the overlay, are shown in figure 1. Notice the statements:

@ASG,T 9.

If the user wishes to plot the data generated during the run at a later date, he must save the contents of unit 9 at end of run, as follows:

@COPY,I 9,FILENAME.ELEMENTNAME

Close attention should be paid to the @ADD statements, as these files contain the input data. The user must generate his own input files. It is obvious that the user will not get plots on the device with a @START command; therefore, if plots are desired, the IPLTWE (I Want Plots While Executing) must be set to 1. Plots will be in microfilm.

Another way to start execution is through the @ADD statement

@ADD ES35-NO6516*LOREN.RUNMIN

Print output will appear on the screen if the IFLGOT flag is set to 1. The user may want to skip this procedure; if so, set IFLGOT to 0.

A user familiar with demand terminal operation should be able to choose the better method.

```
 1:@RUN,R/R 170LOX,E/3207,ES32-L78771,20,50    NODECK LORENZO
 2:@FREE TPF$.
 3:@FREE 9.
 4:@ASG,T 9.,F/1/TRK/500
 5:@ASG,T TPF$.,F/1/TRK/500
 6:@ERS TPF$.
 7:@COPY ES35-N06216*LOREN.,TPF$
 8:@ED,I TPF$.MAP
 9:LIB TPF$
10:LIB DISSPLA*TRY
11:SEG MAIN1
12:NOT DISSPLA*TRY.QQTKEG
13:IN LOREN.QQTKEG
14:IN H800,TBLIN,FAYRID,BINTRP,HANSEN,MOLIER,DINT,DINT1
15:IN MATRES,NEWT,EDPARM,STOCK,HDCOPY
16:SEG WRINP1*,(MAIN1)
17:IN WRINP
18:SEG SETMUP1*,(MAIN1)
19:IN SETMUP
20:SEG OPTMYZ1*,(MAIN1)
21:IN OPTMYZ
22:SEG AIR621*,(MAIN1)
23:IN AIR62
24:SEG ATMS41*,(MAIN1)
25:IN ATMS4
26:SEG TINT61*,(MAIN1)
27:IN TINT6
28:SEG FLOW1*,(MAIN1)
29:IN FLOW
30:SEG PCSW1*,(FLOW1)
31:IN PCSW
32:SEG DWNSTM1*,(FLOW1)
33:IN DWNSTM
34:SEG PMEXPN1*,(FLOW1)
35:IN PMEXPN
36:SEG DOWNID1*,(FLOW1)
37:IN DOWNID
```

Figure 1. - Runstream overlay.

```
38:SEG PMID1%,(FLOW1)
39:IN PMID
40:SEG CRSFLW1%,(MAIN1)
41:IN CRSFLW
42:SEG VRUNL1%,(MAIN1)
43:IN VRUNL
44:SEG SUCYL1,(MAIN1)
45:IN SUCYL
46:SEG ECKERT1%,(MAIN1)
47:IN ECKERT
48:SEG SPCHI1%,(MAIN1)
49:IN SPCHI,FSUBC
50:SEG RHOMUR1%,(MAIN1)
51:IN RHOMUR
52:SEG SUCYL2A%,(MAIN1)
53:IN SUCYL2
54:SEG DETRAL1%,(MAIN1)
55:IN DETRAL
56:SEG TRANS1%,(MAIN1)
57:IN TRANS
58:SEG RADEQT1%,(MAIN1)
59:IN RADEQT
60:SEG PRINT1A%,(MAIN1)
61:IN PRINT1
62:SEG NEWOUT1%,(MAIN1)
63:IN NEWOUT
64:SEG PLOTLO1%,(MAIN1)
65:IN PLOTLO
66:END
67:@PREP
68:@MAP TPF$.MAP,TPF$.ABS
69:@XQT ABS
70:@ADD LO.BD3RD1/C1
```

Figure 1. - Concluded

5. INPUT LISTING

```
 1: $DATALO
 2: ICASE=1,
 3: BDYPNT=24H 1 FT REF. SPHERE
 4: TRANRE=36H (RTLS-EX) 38779
 5:  T1= 0.,    DT1= 25.,    T2= 300.,    DTCALC= .1,    DTEMAX= 10.,
 6:  ATFLAG= 0.,   TIM= 150.,   LNGPLT= 1.,     ENTR= 13.,
 7:  TZ= 0.0, 25.0, 50.0, 75.0, 100.0,110.0, 125.0, 150.0, 175.0,
 8:  200.0, 225.0, 250., 300.0,
 9:  ZZ= 240000.,    230000.,    208000.,    163000.,    133000.,
10:     124000.,    117000.,    110000.,    107000.,    104000.,
11:     99000.,     94000.,     82000.,
12:  UZ=    9300.,      9250.,      9200.,      8800.,      7900.,
13:        7600.,      7200.,      6500.,      5700.,      4900.,
14:        4200.,      3300.,      2500.,
15:  ALFA0T= 50.,      50.,     50.,      50.,      23.,
16:    18.,       16.,       16.,       18.,       19.,
17:    19.5,      17.5,      12.,
18:  HTFLAG= 1.,      RN= 1.,
19: NFF= 0.,   GF(1)= 38., ALFA(1)= 90., GF(2)= 18., ALFA(2)= 90.,
20:  EMATL= 0.,    DEL= 12.,   EMIS= .85,    RHOM= 10000., CPM= 10000.,
21:  ATRE= 0.0,MAXTRE=300,LNGPLT=0,
22: IPUNCH=0, IFLOOT=1, IHCOPY=0,
23: $END
24: $DATALO
25: ICASE=2, RN=1.0,
26: BDYPNT=24H 1 (F)T (R)EF (S)PHERE
27:  ATRE=1,IHCOPY=1,
28: $END
29: $DATALO
30: ICASE=3,
31: BDYPNT=24H (BP) 1100
32: HTFLAG= 1.,   RN= 1.,      DEL= 1.8389, EMIS= .85,
33: GF(1)= 38.,    ALFA(1)= 90.,   GF(2)= 18.,    ALFA(2)= 90.,    NFF= 1.,
34: ARIO= 1.,   ALFA1= 30.,   AKL2Z1= .180, HSLP1= .001,  ALFA2= 35.,
35: AKL2Z2= .217,    HSLP2= .0074,   HSLP3= .0038,
36: ATRE=1.0,
37: $END
38: $DATALO
39: ICASE=4,ALFA(1)=0.0,ALFA(2)=0.0,RN=0.0,
40: BDYPNT=24H (BP) 1400
41: HTFLAG= 4.,    EL= 41.127,   PHI= 1.23,    DEL= 1.62,    EMIS= .85,
42: TRFLAG= 8.,       GF(1)= 38.,     GF(2)= 18.,     NFF= 2.,
43: ALFA(1)=0.,ALFA(2)=0.0,
44: ARIO= 1.,    ALFA1= 70.,   AKL2Z1= 1.94, HSLP1= .044, ALFA2= 40.,
45: AKL2Z2= 1.97,    HSLP2= .002,    HSLP3= .08,
46: ARIT= 1.,   ALFA1T= 90.,  PARA11= 340., PSLP1= .0001, ALFA2T= 30.,
47: PARA12= 242.,     PSLP2= -9.8,     PSLP3= -.462,
48: $END
49: $DATALO
50: ICASE=5,RN=0.0,
51: BDYPNT=24H (BP) 1750
52: HTFLAG= 4.,    EL= 80.5958, PHI= 1.23,    DEL= 1.2322, EMIS= .85,
53: TRFLAG= 8.,       GF(1)= 36.,     GF(2)= 16.,     NFF= 2.,
54: ARIO= 1.,   ALFA1= 20.,   AKL2Z1= 1.11,  HSLP1= .0001, ALFA2= 25.,
55: AKL2Z2= 1.41,    HSLP2= .060,    HSLP3= .0295,
56: ARIT= 1.,     ALFA1T= 20.,    PARA11= 340.,  PSLP1= .0001, ALFA2T= 30.,
57: ALFA(1)=0.0,ALFA(2)=0.0,
58: PARA12= 242.,    PSLP2= -9.8,    PSLP3= -.462,
59: ATRE= 1.,     $END
```

6. OUTPUT LISTING

The listing corresponds to the input shown in section 5.

TRAJECTORY (RTLS-EX) 32779 BODY POINT 1 FT REF. SPHERE ICASE 1
MINIATURE VERSION OF JATC (MINIVER)

TIMING
- T1 = .000
- DT1 = 25.000
- T2 = 300.000
- DT2 = .000
- T3 = .000
- DT3 = .000
- T4 = .000
- DT CALC = .100
- DTEMP MAX = 10.000

HEAT TRANSFER
- HT METHOD = 1.000
- RN = 1.000
- L = .000
- N SUB L = 1.000
- N SUB T = 1.000
- PHI = .000
- VIRT.L OPT = .000

MULTIPLICATION FACTORS
- K SUB L 1 = 1.000
- K SUB T 1 = 1.000
- M FAC = 1.000

2-9

MATERIAL
- MATL NO. = .000
- THICKNESS = 12.000
- EMISSIVITY = .850
- INIT TEMP = 150.000
- DENSITY = 10000.000
- SP. HEAT = 10000.000

FLOWFIELD

	FLAG	ANGLE
1	38.	90.00
2	18.	90.00

TRANSITION
OPTION
TRAJECTORY

TIME	ALTITUDE	VELOCITY
.00	240000.	9300.0
25.00	230000.	9250.0
50.00	202000.	9200.0
75.00	163000.	8800.0
100.00	133000.	7900.0
110.00	124000.	7600.0
125.00	117000.	7200.0
150.00	110000.	6500.0

175.00	107000.	5700.C
200.00	104000.	4900.C
225.00	99000.	4200.C
250.00	94000.	3300.C
300.00	82000.	2500.C

1962 ICAO ATMOSPHERE

TIME= 0. Z= 240000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9300.	5.82	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2863-06
O			.6872+03	9.074	1.1261	1816.	4197.	.1067-05	.1487-05
L		5.67	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2863-06
D	1011.	.33	.6891+03	8.536	1.1259	1795.	4173.	.1010-05	.1482-05
E	0.	.00	.1686-11	9.074	1.1261	1816.	4197.	.1067-05	.1487-05
W		X L=	.0000	C P= 1.896	1.3954	146.	15C.	.8664-05	.4228-06
*			.0000		1.2403	0.	-46C.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.2509-02	.1816+04	.4857+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1816+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT				
CONV	4.857	0.	HC(H)= .2909-02	H RECOV = 1815.8		
RAD EQ	3.993	0.	HC(T)= .1200-02	T RECOV = 4197.		
RAD	.056			T RAD EQ= 1313.		
NET	4.802	0.				
CL	5.282	0.				

TEMPERATURE (DEG F) = 150.00

S/R	= 39.61
PR	= .7100
CF/2	= .0000
TAU W	= .2122-15
DELTA	= .0000
DEL *	= .0000
THETA	= .0000
R	= 1.000
L	= .0000
PHI	= .00
EMIS	= .8500
ALPHA	= 90.00
BETA	= 90.00
LEWIS	= 1.350
MDS	= 1072.
PCT	= .000
PAPA	= .0000
RET/ML	= .0000
RE E	= .0000
TDOT	= .000
IT	= 1

6-4

TIME= 25. Z= 230000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9350.	5.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06
O			.1043+04	13.85	1.1289	1840.	4279.	.1601-05	.1501-05
U		5.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06
D	1024.	.33	.1046+04	13.15	1.1287	1619.	4255.	.1529-05	.1497-05
E	129.	.04	.1376+03	13.85	1.1289	1839.	4281.	.1600-05	.1501-05
W		X L=	.0000	C P= 1.877	1.3954	146.	15C.	.1323-04	.4228-06
*			.3000		1.2412	0.	-46C.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.3572-02	.1840+04	.6849+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1840+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT				
CONV	6.049	135.	HC(H)= .3572-02	H RECOV = 1839.6		
RAD EQ	4.897	110.	HC(T)= .1465-02	T RECOV = 4279.		
RAD	.056			T RAD EQ= 1406.		
NET	5.993	133.				
CL	6.570	146.				

TEMPERATURE (DEG F) = 150.00

S/R	= 39.22
PR	= .7100
CF/2	= .0000
TAU W	= .1432-01
DELTA	= .0000
DEL *	= .0000
THETA	= .0000
R	= 1.000
L	= .0000
PHI	= .00
EMIS	= .8500
ALPHA	= 90.00
BETA	= 90.00
LEWIS	= 1.350
MDS	= 998.
PCT	= .000
PAPA	= .0000
RET/ML	= .0000
RE E	= .0000
TDOT	= .000
IT	= 11

TIME= 50. Z= 202000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9200.	8.80	.1333+05	.3813	1.4000	109.	-5.	.4884-06	.3370-06
O			.2953+04	39.28	1.1367	1798.	440C.	.4473-05	.1522-05
U		8.80	.1333+05	.3813	1.4000	109.	-5.	.4884-06	.3370-06
D	1662.	.34	.2962+04	36.90	1.1366	1776.	4372.	.4233-05	.1517-05
E	0.	.00	.6831-11	39.26	1.1367	1798.	440C.	.4473-05	.1522-05
W		X L= .0000	C P= 1.862	1.3954		146.	15C.	.3750-04	.4228-06
*		.0000		1.2557		0.	-46C.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5567-02	.1798+04	.9860+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1798+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	9.860	326.
RAD EQ	7.579	261.
RAD	.056	
NET	9.804	323.
CW	10.731	354.

HC(H)= .5967-02 H RECOV = 1798.5
HC(T)= .2320-02 T RECOV = 4400.
T RAD EQ= 1621.

TEMPERATURE (DEG F) = 150.00

S/R	=	38.02	
PR	=	.7100	
ST	=	.4127-01	
CF/2	=	.0000	
TAU W	=	.4306-15	
DELTA	=	.0000	
DEL *	=	.0000	
THETA	=	.0000	

R	=	1.000	
L	=	.0000	
PHI	=	.00	
EMIS	=	.8500	
ALPHA	=	90.00	
BETA	=	90.00	
LEWIS	=	1.351	
MDS	=	850.	
PCT	=	.000	
PARA	=	.0000	
RET/ML	=	.0000	
RE E	=	.0000	
TDOT	=	.000	
IT	=	21	

TIME= 75. Z= 163000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	8800.	8.13	.5124+05	1.733	1.4000	117.	27.	.2072-05	.3559-06
O			.1193+05	151.5	1.1547	1663.	4444.	.1741-04	.1529-05
U		8.13	.5124+05	1.733	1.4000	117.	27.	.2072-05	.3559-06
D	1107.	.35	.1198+05	141.9	1.1556	1638.	4405.	.1647-04	.1522-05
E	0.	.00	.2532-10	151.5	1.1547	1663.	4444.	.1741-04	.1529-05
W		X L= .0000	C P= 1.866	1.3954		146.	15C.	.1446-03	.4228-06
*		.0000		1.2771		0.	-46C.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1149-01	.1663+04	.1742+02	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1663+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	17.423	650.
RAD EQ	12.193	500.
RAD	.056	
NET	17.367	646.
CW	19.100	709.

HC(H)= .1149-01 H RECOV = 1662.5
HC(T)= .4057-02 T RECOV = 4444.
T RAD EQ= 1663.

TEMPERATURE (DEG F) = 150.00

S/R	=	36.20	
PR	=	.7100	
ST	=	.1958-01	
CF/2	=	.0000	
TAU W	=	.7931-15	
DELTA	=	.0000	
DEL *	=	.0000	
THETA	=	.0000	

R	=	1.000	
L	=	.0000	
PHI	=	.00	
EMIS	=	.8500	
ALPHA	=	90.00	
BETA	=	90.00	
LEWIS	=	1.351	
MDS	=	547.	
PCT	=	.000	
PARA	=	.0000	
RET/ML	=	.0000	
RE E	=	.0000	
TDOT	=	.000	
IT	=	31	

TIME= 100. Z= 133000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	7500.	7.57	.1685+06	5.578	1.4000	109.	-6.	.7168-05	.3361-06
O			.3873+05	419.2	1.1961	1354.	4057.	.5344-04	.1462-05
U		7.57	.1685+06	5.578	1.4000	109.	-6.	.7168-05	.3361-06
O	1129.	.37	.3898+05	388.6	1.1985	1329.	4004.	.5016-04	.1453-05
E	264.	.09	.9672+04	419.2	1.1964	1353.	4054.	.5348-04	.1462-05
W		X L= .0000 C		P= 1.649	1.3954	146.	150.	.4002-03	.4228-06
*		.0000			1.3005	0.	-460.	.0000	.0000

	M	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1884-01	.1354+04	.2276+02	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1354+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	22.766	1140.
RAD EQ	13.792	822.
RAD	.056	
NET	22.711	1134.
CW	25.516	1251.

HC(H)= .1884-01 H RECOV = 1354.4
HC(T)= .5827-02 T RECOV = 4057.
T RAD EQ= 1957.

TEMPERATURE (DEG F) = 153.00

S/R = 34.21
PR = .7100
ST = .1034-01
CF/2 = .0000
TAU W = .1546+00
DELTA = .0000
DEL * = .0000
THETA = .0000
LEWIS = 1.351
MDS = 349.
PCT = .000
PARA = .0000
RET/RL = .0000
RE E = .0000
TDOT = .000
IT = 41
R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00

TIME= 125. Z= 117000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	7200.	7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06
O			.7780+05	727.2	1.2409	1138.	3562.	.1048-03	.1372-05
U		7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06
O	1101.	.38	.7851+05	661.6	1.2451	1113.	3496.	.9701-04	.1360-05
E	0.	.00	.1389-09	727.2	1.2409	1138.	3562.	.1048-03	.1372-05
W		X L= .0000 C		P= 1.864	1.3954	146.	150.	.6943-03	.4228-06
*		.0000			1.3124	0.	-460.	.0000	.0000

	M	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.2450-01	.1138+04	.2438+02	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1138+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	24.298	1743.
RAD EQ	12.907	1165.
RAD	.056	
NET	24.242	1736.
CW	27.874	1933.

HC(H)= .2450-01 H RECOV = 1137.6
HC(T)= .7121-02 T RECOV = 3562.
T RAD EQ= 1917.

TEMPERATURE (DEG F) = 150.00

S/R = 32.93
PR = .7100
ST = .7132-02
CF/2 = .0000
TAU W = .1384-14
DELTA = .0000
DEL * = .0000
THETA = .0000
LEWIS = 1.351
MDS = 255.
PCT = .000
PARA = .0000
RET/RL = .0000
RE E = .0000
TDOT = .000
IT = 51
R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00

TIME= 150. Z= 110000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	6500.	6.48	.4265+06	14.84	1.4000	100.	-41.	.2066-04	.3149-06
O			.1060+06	817.6	1.2770	944.	3015.	.1368-03	.1267-05
U		6.48	.4265+06	14.84	1.4000	100.	-41.	.2066-04	.3149-06
D	1055.	.30	.1072+06	745.7	1.2795	921.	295C.	.1273-03	.1253-05
E	0.	.00	.1773-09	817.6	1.2770	944.	3015.	.1368-03	.1267-05
W		X L=	.0000	C P= 1.839	1.3954	146.	15C.	.7806-03	.4228-06
*			.0000		1.3245	0.	-46C.	.0000	.0000

	H	HP	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.2562-01	.9437+03	.2044+02	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.9437+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	20.438	2306.
RAD EQ	9.700	1451.
RAD	.056	
NET	20.382	2298.
C&	24.177	2588.

HC(H)= .2562-01 H RECOV = 943.7
HC(T)= .7123-02 T RECOV = 3019.
T RAD EQ= 1753.

S/R = 32.05
PR = .7100
ST = .5930-02
CF/2 = .0000
TAU W = .1306-14
DELTA = .0000
DEL * = .0000
THETA = .0000
LEWIS = 1.351
MDS = 191.

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00

PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000

TDOT = .000

IT = 61

TEMPERATURE (DEG F) = 150.00

TIME= 175. Z= 107000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	5730.	5.72	.4361+06	16.96	1.4000	99.	-46.	.2387-04	.3120-06
O			.1201+06	731.1	1.3007	748.	2391.	.1493-03	.1133-05
U		5.72	.4361+06	16.96	1.4000	99.	-46.	.2387-04	.3120-06
D	990.	.40	.1217+06	657.2	1.3029	728.	2323.	.1375-03	.1118-05
E	0.	.00	.1896-09	731.1	1.3007	748.	2391.	.1493-03	.1133-05
W		X L=	.0000	C P= 1.841	1.3954	146.	15C.	.6980-03	.4226-06
*			.0000		1.3377	0.	-46C.	.0000	.0000

	H	HP	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.2362-01	.7478+03	.1434+02	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.7478+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	14.336	2746.
RAD EQ	6.001	1649.
RAD	.056	
NET	14.280	2736.
C&	17.813	3118.

HC(H)= .2382-01 H RECOV = 747.8
HC(T)= .6396-02 T RECOV = 2391.
T RAD EQ= 1503.

S/R = 31.27
PR = .7100
ST = .5441-02
CF/2 = .0000
TAU W = .1065-14
DELTA = .0000
DEL * = .0000
THETA = .0000
LEWIS = 1.351
MDS = 147.

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00

PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000

TDOT = .000

IT = 71

TEMPERATURE (DEG F) = 150.00

TIME= 200. Z= 104000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	4500.	4.93	.4350+06	19.41	1.4000	99.	-46.	.2753-04	.3101-06
O			.1360+06	630.3	1.3200	578.	1795.	.1624-03	.9917-06
U		4.97	.4350+06	19.41	1.4000	99.	-46.	.2753-04	.3101-06
D	916.	.41	.1382+06	555.8	1.3223	561.	1737.	.1472-03	.9759-06
E	0.	.00	.2027-09	630.3	1.3200	578.	1795.	.1624-03	.9917-06
W		X L=	.0000 C	P= 1.848	1.3954	146.	15C.	.6018-03	.4228-06
*			.0000		1.3528	0.	-46C.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.2164-01	.5778+03	.9346+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.5778+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	9.346	3045.
RAD EQ	3.359	1767.
RAD	.056	
NET	9.290	3033.
CW	12.504	3500.

HC(H)= .2164-01 H RECOV = 577.8
HC(T)= .5667-02 T RECOV = 1799.
T RAD EQ= 1238.

S/R = 30.44
PR = .7100
ST = .4986-02
CF/2 = .0000
TAU W = .8319-15
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.351
MDS = 109.
PCT = .000
PARA = .0000
RET/PL = .0000
RE E = .0000
TOOT = .000
IT = 81

TEMPERATURE (DEG F) = 150.00

TIME= 225. Z= 99000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	4200.	4.24	.4735+06	24.35	1.4000	98.	-52.	.3477-04	.3084-06
O			.1688+06	571.7	1.3372	450.	1337.	.1852-03	.8665-06
U		4.24	.4735+06	24.35	1.4000	98.	-52.	.3477-04	.3084-06
D	853.	.43	.1716+06	512.8	1.3392	435.	1284.	.1712-03	.8511-06
E	0.	.00	.2268-09	571.7	1.3372	450.	1337.	.1852-03	.8665-06
W		X L=	.0000 C	P= 1.785	1.3954	146.	15C.	.5459-03	.4228-06
*			.0000		1.3675	0.	-46C.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.2008-01	.4500+03	.6106+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.4500+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	6.106	3240.
RAD EQ	1.822	1633.
RAD	.056	
NET	6.050	3229.
CW	9.037	3772.

HC(H)= .2008-01 H RECOV = 450.0
HC(T)= .5144-02 T RECOV = 1337.
T RAD EQ= 997.

S/R = 29.59
PR = .7100
ST = .4274-02
CF/2 = .0000
TAU W = .6616-15
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.351
MDS = 76.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TOOT = .000
IT = 91

TEMPERATURE (DEG F) = 150.00

TIME= 250. Z= 84000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	3300.	3.34	.4732+06	30.60	1.4000	97.	-54.	.4398-04	.3067-06
O			.2062+06	460.1	1.3636	315.	822.	.2089-03	.7038-06
U		3.34	.4732+06	30.60	1.4000	97.	-54.	.4398-04	.3067-06
D	777.	.46	.2112+06	396.3	1.3664	302.	775.	.1868-03	.6871-06
E	0.	.00	.2474-09	460.1	1.3636	315.	822.	.2089-03	.7038-06
W		X L=	.0000 C	P= 1.754	1.3954	146.	15C.	.4393-03	.4228-06
*			.0000		1.383C	C.	-46C.	.0000	.0000

	S/R = 28.39	R = 1.000
	PR = .7100	L = .0000
	ST = .3697-02	PHI = .00
	CF/2 = .0000	EMIS = .8500
	TAU W = .4470-15	ALPHA = 90.00
	DELTA = .0000	BETA = 90.00
	DEL * = .0000	
	THETA = .0000	LEWIS = 1.351
		MDS = 46.

	H	HR	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1727-01	.3146+03	.2912+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.3146+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000

	Q	Q TOT
CONV	2.912	3355.
RAD EQ	.664	1863.
RAD	.056	
NET	2.856	3341.
CW	5.432	3957.

HC(H)= .1727-01 H RECOV = 314.6
HC(T)= .4331-02 T RECOV = 822.
T RAD EQ= 672.

TDOT = .000

IT = 101

TEMPERATURE (DEG F) = 150.00

6-9

TIME= 275. Z= 88000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	2900.	2.95	.5563+06	40.33	1.4000	96.	-56.	.5844-04	.3047-06
O			.2681+06	463.7	1.3752	264.	626.	.2486-03	.6321-06
U		2.95	.5563+06	40.33	1.4000	96.	-58.	.5844-04	.3047-06
D	750.	.48	.2755+06	404.4	1.3778	253.	582.	.2260-03	.6153-06
E	82.	.05	.3245+05	463.7	1.3752	264.	625.	.2486-03	.6321-06
W		X L=	.0000 C	P= 1.723	1.3954	146.	15C.	.4427-03	.4226-06
*			.0000		1.3688	0.	-46C.	.0000	.0000

	S/R = 27.76	R = 1.000
	PR = .7100	L = .0000
	ST = .3094-02	PHI = .00
	CF/2 = .0000	EMIS = .8500
	TAU W = .4321-01	ALPHA = 90.00
	DELTA = .0000	BETA = 90.00
	DEL * = .0000	
	THETA = .0000	LEWIS = 1.351
		MDS = 33.

	H	HR	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1687-01	.2643+03	.1997+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.2643+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000

	C	Q TOT
CONV	1.998	3418.
RAD EQ	.395	1877.
RAD	.056	
NET	1.942	3402.
CW	4.460	4081.

HC(H)= .1687-01 H RECOV = 264.3
HC(T)= .4198-02 T RECOV = 626.
T RAD EQ= 534.

TDOT = .000

IT = 111

TEMPERATURE (DEG F) = 150.00

TIME= 300. Z= 02000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	2500.	2.55	.6432+06	53.29	1.4000	96.	-61.	.7785-04	.3026-06
O			.3452+06	452.9	1.3853	220.	454.	.2884-03	.5638-06
U		2.55	.6432+06	53.29	1.4000	96.	-61.	.7785-04	.3026-06
D	735.	.51	.3566+06	396.6	1.3878	210.	412.	.2648-03	.5459-06
E	30.	.07	.1541+05	452.9	1.3853	220.	454.	.2825-03	.5637-06
W		X L=	.0000	C P= 1.643	1.3954	146.	150.	.4324-03	.4226-06
*			.0000		1.3917	0.	-460.	.0000	.0000

	M	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1620-01	.2204+03	.1207+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.2204+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	1.207	3458.
RAD EQ	.222	1884.
RAD	.056	
NET	1.151	3442.
CW	3.572	4183.

HC(H)= .1620-01 H RECOV = 220.5
HC(T)= .3968-02 T RECOV = 454.
T RAD EQ= 401.

TEMPERATURE (DEG F) = 150.00

QC MAX= 29.67 TIME= 110.
TW MAX= 150. TIME= 0.

S/R = 27.24
PR = .7100
CF/2 = .0000
TAU W = .1515-01
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.351
HDS = 28.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TDCT = .000
IT = 121

TRAJECTORY (RTLS-EX) 32779 BODY POINT 1 (F)T (R)EF (S)PHERE ICASE 2
MINIATURE VERSION OF JA70 (MINIVER)

TIMING

T1	=	.000
DT1	=	25.000
T2	=	300.000
DT2	=	.000
T3	=	.000
DT3	=	.000
T4	=	.000
DT CALC	=	.100
DTEMP MAX	=	10.000

HEAT TRANSFER

HT METHOD	=	1.000
RN	=	1.000
L	=	.000
N SUB L	=	1.000
N SUB T	=	1.000
PHI	=	.000
VIRT.L OPT	=	.000

MULTIPLICATION FACTORS

K SUB L 1	=	1.000
K SUB T 1	=	1.000
H FAC	=	1.000

MATERIAL

MATL NO.	=	.000
THICKNESS	=	12.000
EMISSIVITY	=	.850
INIT TEMP	=	190.000
DENSITY	=	10000.000
SP. HEAT	=	10000.000

FLOWFIELD

	FLAG	ANGLE
1	3E.	90.00
2	1E.	90.00

TRANSITION OPTION

TRAJECTORY

TIME	ALTITUDE	VELOCITY
.00	240000.	9300.0
25.00	230000.	9350.0
50.00	202000.	9200.0
75.00	163000.	8800.0
100.00	133000.	7900.0
110.00	124000.	7600.0
125.00	117000.	7200.0
150.00	110000.	6500.0

175.00	107000.	5700.0
200.00	104000.	4900.0
225.00	98000.	4200.0
250.00	94000.	3300.0
300.00	82000.	2500.0

1962 ICAO ATMOSPHERE

TIME= 0. Z= 240000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9300.	5.82	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2863-06
O			.6872+03	9.074	1.1261	1816.	4197.	.1067-05	.1487-05
L		5.82	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2863-06
D	1011.	.33	.6891+03	8.536	1.1259	1795.	4173.	.1010-05	.1482-05
E	0.	.00	.1686-11	9.074	1.1261	1816.	4197.	.1067-05	.1487-05
W		X L =	.0000	C P= 1.856	1.3382	443.	1313.	.2980-05	.8594-06
*			.0000		1.2403	0.	-460.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.2909-02	.1816+04	.3992+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1816+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	3.993	0.
RAD EQ	3.993	0.
RAD	3.993	
NET	.000	0.
CL	5.282	0.

HC(H)= .2909-02 H RECOV = 1815.8
HC(T)= .1365-02 T RECOV = 4197.
T RAD EQ= 1313.

TEMPERATURE (DEG F) = 1312.85

S/R = 39.61
PR = .7100
ST = .8850-01
CF/2 = .0000
TAU W = .2122-15
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.350
MDS = 1072.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TDOT = .000
IT = 1

TIME= 25. Z= 230000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9350.	5.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06
O			.1043+04	13.65	1.1289	1840.	4279.	.1601-05	.1501-05
L		5.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06
D	1024.	.33	.1046+04	13.15	1.1287	1819.	4255.	.1529-05	.1497-05
E	129.	.04	.1376+03	13.65	1.1289	1839.	4281.	.1600-05	.1501-05
W		X L =	.0000	C P= 1.877	1.3353	465.	1390.	.4360-05	.8816-06
*			.0000		1.1985	0.	-460.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.3441-02	.1840+04	.4732+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1840+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	4.733	107.
RAD EQ	4.733	107.
RAD	4.733	
NET	.000	0.
CL	6.331	142.

HC(H)= .3441-02 H RECOV = 1839.6
HC(T)= .1638-02 T RECOV = 4279.
T RAD EQ= 1390.

TEMPERATURE (DEG F) = 1389.75

S/R = 39.22
PR = .7100
ST = .8832-01
CF/2 = .0000
TAU W = .1380-01
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.351
MDS = 998.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TDOT = .000
IT = 11

TIME= 50. Z= 202000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 38.02	R = 1.000
										PR = .7100	L = .0000
I	9200.	E.80	.1333+05	.3813	1.4000	109.	-5.	.4884-06	.3370-06	ST = .3961-01	PHI = .00
O			.2953+04	39.28	1.1367	1798.	4400.	.4473-05	.1522-05	CF/2 = .0000	EMIS = .8500
E		E.80	.1333+05	.3813	1.4000	109.	-5.	.4884-06	.3370-06		
D	1062.	.34	.2962+04	36.90	1.1366	1776.	4372.	.4233-05	.1517-05	TAU W = .4133-15	ALPHA = 90.00
E	0.	.00	.6831-11	39.28	1.1367	1798.	4400.	.4473-05	.1522-05	DELTA = .0000	BETA = 90.00
W		X L=	.0000	C P= 1.862	1.3274	523.	1602.	.1169-04	.9401-06	DEL * = .0000	
*			.0000		1.2069	0.	-460.	.0000	.0000	THETA = .0000	LEWIS = 1.353
											MDS = 850.

	M	MP	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5726-02	.1798+04	.7302+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1798+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000

	C	Q TOT
CONV	7.307	252.
RAD EQ	7.307	252.
RAD	7.307	
NET	.000	0.
CW	10.299	341.

MC(M) = .5726-02 H RECOV = 1798.5
MC(T) = .2612-02 T RECOV = 4400.
T RAD EQ = 1602.

TDOT = .000

IT = 21

TEMPERATURE (DEG F) = 1501.91

6-14

TIME= 75. Z= 163000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 36.20	R = 1.000
										PR = .7100	L = .0000
I	8800.	E.13	.5124+05	1.733	1.4000	117.	27.	.2072-05	.3559-06	ST = .1870-01	PHI = .00
O			.1197+05	151.5	1.1547	1663.	4444.	.1741-04	.1529-05	CF/2 = .0000	EMIS = .8500
E		E.13	.5124+05	1.733	1.4000	117.	27.	.2072-05	.3559-06		
D	1107.	.35	.1199+05	141.9	1.1556	1638.	4405.	.1647-04	.1522-05	TAU W = .7574-15	ALPHA = 90.00
E	0.	.00	.2532-10	151.5	1.1547	1663.	4444.	.1741-04	.1529-05	DELTA = .0000	BETA = 90.00
W		X L=	.0000	C P= 1.866	1.3177	595.	1860.	.3800-04	.1007-05	DEL * = .0000	
*			.0000		1.2288	0.	-460.	.0000	.0000	THETA = .0000	LEWIS = 1.353
											MDS = 547.

	M	MP	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1097-01	.1663+04	.1171+02	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.1663+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000

	C	Q TOT
CONV	11.722	482.
RAD EQ	11.722	482.
RAD	11.722	
NET	.000	0.
CW	16.240	681.

MC(M) = .1097-01 H RECOV = 1662.5
MC(T) = .4536-02 T RECOV = 4444.
T RAD EQ = 1860.

TDOT = .000

IT = 31

TEMPERATURE (DEG F) = 1860.47

TIME= 100. Z= 113000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU				
I	7400.	7.57	.1685+06	5.578	1.4000	109.	-6.	.7168-05	.3361-06	S/R	= 34.21	R	= 1.000
O			.3873+05	419.2	1.1961	1359.	4057.	.5344-04	.1462-05	PR	= .7100	L	= .0000
U		7.57	.1685+06	5.578	1.4000	109.	-6.	.7168-05	.3361-06	CF/2	= .0000	PHI	= .00
D	1129.	.37	.3898+05	386.6	1.1985	1329.	4004.	.5016-04	.1453-05	TAU W	= .1474+00	EMIS	= .8500
E	264.	.09	.9672+04	419.2	1.1964	1353.	4054.	.5348-04	.1462-05	DELTA	= .0000	ALPHA	= 90.00
W		X L=	.0000	C P= 1.849	1.3153	616.	1934.	.1020-03	.1025-05	DEL *	= .0000	BETA	= 90.00
*			.0000		1.2692	0.	-460.	.0000	.0000	THETA	= .0000	LEWIS	= 1.353
												MDS	= 349.

	M	HP	GC	K1	K2	K3	R	HFAC	HFAC1	HFAC2		
LAMINAR	.1796-01	.1354+04	.1326+02	1.000	1.000	1.000	1.000	1.000	1.000	1.000	PCT	= .000
TURBULENT	.0000	.1354+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	PARA	= .0000
											RET/PL	= .0000
											RE E	= .0000

	C	Q TOT				
CONV	13.270	792.	HC(H)= .1796-01	H RECOV = 1354.4		
RAD EQ	13.270	792.	HC(T)= .6250-02	T RECOV = 4057.	TDOT	= .000
RAD	13.270			T RAD EQ= 1934.		
NET	.000	0.				
CW	24.326	1198.			IT	= 41

TEMPERATURE (DEG F) = 1933.54

TIME= 125. Z= 117000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU				
I	7200.	7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06	S/R	= 32.93	R	= 1.000
O			.7760+05	727.2	1.2409	1138.	3562.	.1048-03	.1372-05	PR	= .7100	L	= .0000
U		7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06	CF/2	= .0000	PHI	= .00
D	1101.	.38	.7851+05	661.6	1.2451	1113.	3496.	.9701-04	.1360-05	TAU W	= .1320-14	EMIS	= .8500
E	0.	.00	.1389-09	727.2	1.2409	1138.	3562.	.1048-03	.1372-05	DELTA	= .0000	ALPHA	= 90.00
W		X L=	.0000	C P= 1.864	1.3165	605.	1896.	.1797-03	.1016-05	DEL *	= .0000	BETA	= 90.00
*			.0000		1.2857	0.	-460.	.0000	.0000	THETA	= .0000	LEWIS	= 1.362
												MDS	= 255.

	M	HP	GC	K1	K2	K3	R	HFAC	HFAC1	HFAC2		
LAMINAR	.2337-01	.1138+04	.1245+02	1.000	1.000	1.000	1.000	1.000	1.000	1.000	PCT	= .000
TURBULENT	.0000	.1138+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	PARA	= .0000
											RET/PL	= .0000
											RE E	= .0000

	C	Q TOT				
CONV	12.451	1122.	HC(H)= .2337-01	H RECOV = 1137.6		
RAD EQ	12.451	1122.	HC(T)= .7472-02	T RECOV = 3562.	TDOT	= .000
RAD	12.451			T RAD EQ= 1896.		
NET	.000	0.				
CW	24.562	1849.			IT	= 51

TEMPERATURE (DEG F) = 1895.73

TIME= 150. Z= 110000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU				
I	6500.	6.48	.4265+06	14.84	1.4000	100.	-41.	.2066-04	.3149-06	S/R	= 32.05	R	= 1.000
O			.1060+06	817.6	1.2770	944.	3015.	.1368-03	.1267-05	PR	= .7100	L	= .0000
U		6.48	.4265+06	14.84	1.4000	100.	-41.	.2066-04	.3149-06	ST	= .5671-02	PHI	= .00
D	1055.	.39	.1072+05	745.7	1.2795	921.	2950.	.1273-03	.1253-05	CF/2	= .0000	EMIS	= .8500
E	0.	.00	.1773-09	817.6	1.2770	944.	3015.	.1368-03	.1267-05	TAU W	= .1249-14	ALPHA	= 90.00
W			Y L= .0000	C P= 1.639	1.3224	560.	1736.	.2168-03	.9754-06	DELTA	= .0000	BETA	= 90.00
*			.0000		1.3000	0.	-460.	.0000	.0000	DEL *	= .0000		
										THETA	= .0000	LEWIS	= 1.352
												HOS	= 191.

	W	HP	GC	K1	K2	K3	M	HFAC	HFAC1	HFACZ
LAMINAR	.2450-01	.9437+03	.9393+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.9437+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT				
CONV	9.397	1398.	HC(H)= .2450-01	H RECOV =	943.7	
RAD EQ	9.397	1398.	HC(T)= .7322-02	T RECOV =	3019.	
RAD	9.397			T RAD EQ=	1736.	
NET	.000	0.				
CW	21.120	2474.				

PCT = .000
PARA = .0000
RET/RL = .0000
RE E = .0000
TOCT = .000
IT = 61

TEMPERATURE (DEG F) = 1735.71

6-16

TIME= 175. Z= 107000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU				
I	5700.	5.72	.4361+06	16.96	1.4000	99.	-46.	.2387-04	.3120-06	S/R	= 31.27	R	= 1.000
O			.1201+06	731.1	1.3007	748.	2391.	.1493-03	.1133-05	PR	= .7100	L	= .0000
U		5.72	.4361+06	16.97	1.4000	99.	-46.	.2387-04	.3120-06	ST	= .5227-02	PHI	= .00
D	590.	.40	.1217+06	657.2	1.3029	728.	2323.	.1375-03	.1118-05	CF/2	= .0000	EMIS	= .8500
E	0.	.00	.1896-09	731.1	1.3007	748.	2391.	.1493-03	.1133-05	TAU W	= .1023-14	ALPHA	= 90.00
W			Y L= .0000	C P= 1.641	1.3315	492.	1490.	.2182-03	.9098-06	DELTA	= .0000	BETA	= 90.00
*			.0000		1.3144	0.	-460.	.0000	.0000	DEL *	= .0000		
										THETA	= .0000	LEWIS	= 1.352
												HOS	= 147.

	W	HP	GC	K1	K2	K3	M	HFAC	HFAC1	HFACZ
LAMINAR	.2289-01	.7478+03	.5845+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.7478+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT				
CONV	5.849	1591.	HC(H)= .2289-01	H RECOV =	747.6	
RAD EQ	5.849	1591.	HC(T)= .6491-02	T RECOV =	2391.	
RAD	5.849			T RAD EQ=	1490.	
NET	.000	0.				
CW	17.113	2982.				

PCT = .000
PARA = .0000
RET/RL = .0000
RE E = .0000
TOCT = .000
IT = 71

TEMPERATURE (DEG F) = 1490.30

TIME= 200. Z= 10+000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	4900.	4.93	.4350+06	19.41	1.4000	99.	-45.	.2753-04	.3101-06
O			.1360+06	630.3	1.3200	578.	1795.	.1624-03	.9917-06
U		4.93	.4350+06	19.41	1.4000	99.	-45.	.2753-04	.3101-06
D	916.	.41	.1382+06	555.8	1.3223	561.	1737.	.1472-03	.9759-06
E	0.	.00	.2027-09	630.3	1.3200	578.	1795.	.1624-03	.9917-06
W		X L =	.0000	C P= 1.648	1.3413	420.	1230.	.2172-03	.8349-06
*			.0000		1.3301	0.	-460.	.0000	.0000

	H	HP	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.2091-01	.5778+03	.3294+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.5778+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	3.294	1706.
RAD EQ	3.294	1706.
RAD	3.294	
NET	.000	0.
CW	12.061	3349.

HC(H)= .2091-01 H RECOV = 577.8
HC(T)= .5784-02 T RECOV = 1799.
T RAD EQ= 1230.

TEMPERATURE (DEG F) = 1229.56

S/R = 30.44
PR = .7100
ST = .4817-02
CF/2 = .0000
TAU W = .6037-15
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.352
HDS = 109.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TDOT = .000
IT = 81

TIME= 225. Z= 99000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	4200.	4.24	.4735+06	24.35	1.4000	98.	52.	.3477-04	.3084-06
O			.1665+06	571.7	1.3372	450.	1337.	.1852-03	.8665-06
U		4.24	.4735+06	24.35	1.4000	98.	-52.	.3477-04	.3084-06
D	853.	.43	.1716+06	512.8	1.3393	435.	1284.	.1712-03	.8511-06
E	0.	.00	.2268-09	571.7	1.3372	450.	1337.	.1852-03	.8665-06
W		X L =	.0000	C P= 1.785	1.3537	358.	992.	.2293-03	.7608-06
*			.0000		1.3430	0.	-460.	.0000	.0000

	H	HP	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1952-01	.4500+03	.1796+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.4500+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	1.796	1771.
RAD EQ	1.796	1771.
RAD	1.796	
NET	.000	0.
CW	8.782	3613.

HC(H)= .1952-01 H RECOV = 450.0
HC(T)= .5205-02 T RECOV = 1337.
T RAD EQ= 992.

TEMPERATURE (DEG F) = 991.94

S/R = 29.59
PR = .7100
ST = .4154-02
CF/2 = .0000
TAU W = .6430-15
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.352
HDS = 76.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TDOT = .000
IT = 91

TIME= 250. Z= 94000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	3300.	3.34	.4732+06	30.60	1.4000	97.	-54.	.4398-04	.3067-06
O			.2062+06	460.1	1.3636	315.	822.	.2089-03	.7038-06
U		3.34	.4732+06	30.60	1.4000	97.	-54.	.4398-04	.3067-06
D	777.	.46	.2112+06	396.3	1.3664	302.	775.	.1868-03	.6871-06
E	0.	.00	.2474-09	460.1	1.3636	315.	822.	.2089-03	.7038-06
W		X L= .0000	C P= 1.794		1.3726	276.	670.	.2371-03	.6490-06
*		.0000			1.3672	0.	-460.	.0000	.0000

	H	HR	GC	K1	K2	K3	K	FAC	HFAC1	HFAC2
LAMINAR	.1693-01	.3146+03	.6593+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.3146+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	.659	1801.
RAD EQ	.659	1801.
RAD	.659	
NET	.000	0.
CH	5.326	3793.

HC(H)= .1693-01 H RECOV = 314.6
HC(T)= .4329-02 T RECOV = 822.
T RAD EQ= 670.

S/R = 28.39
PR = .7100
CF/2 = .0000
TAU W = .4382-15
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.351
MDS = 46.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TDOT = .000
IT = 101

TEMPERATURE (DEG F) = 670.20

TIME= 275. Z= 88000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	2500.	2.95	.5563+06	40.33	1.4000	96.	-58.	.5844-04	.3047-06
O			.2681+06	463.7	1.3752	264.	626.	.2486-03	.6323-06
U		2.95	.5563+06	40.33	1.4000	96.	-58.	.5844-04	.3047-06
D	750.	.48	.2755+06	404.4	1.3778	253.	582.	.2260-03	.6153-06
E	82.	.05	.3245+05	463.7	1.3752	264.	625.	.2488-03	.6321-06
W		X L= .0000	C P= 1.723		1.3806	241.	533.	.2718-03	.5961-06
*		.0000			1.3775	0.	-460.	.0000	.0000

	H	HR	GC	K1	K2	K3	K	FAC	HFAC1	HFAC2
LAMINAR	.1662-01	.2643+03	.3931+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.2643+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	.393	1815.
RAD EQ	.393	1815.
RAD	.393	
NET	.000	0.
CH	4.395	3915.

HC(H)= .1662-01 H RECOV = 264.3
HC(T)= .4251-02 T RECOV = 626.
T RAD EQ= 533.

S/R = 27.76
PR = .7100
CF/2 = .0000
TAU W = .4257-01
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.351
MDS = 33.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TDOT = .000
IT = 111

TEMPERATURE (DEG F) = 533.35

TIME= 300. Z= 82000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	2500.	2.55	.6432+06	53.29	1.4000	96.	-61.	.7785-04	.3026-06
O			.3452+06	452.9	1.3853	220.	454.	.2884-03	.5638-06
U		2.55	.6432+06	53.29	1.4000	96.	-61.	.7785-04	.3026-06
D	735.	.51	.3566+06	396.6	1.3878	210.	412.	.2648-03	.5459-06
E	30.	.02	.1541+05	452.9	1.3853	220.	454.	.2885-03	.5637-06
W		X L=	.0000	C P= 1.643	1.3885	207.	400.	.3065-03	.5408-06
*			.0000		1.3865	0.	-460.	.0000	.0000

	S/R	= 27.24	R	= 1.000
	PR	= .7100	L	= .0000
	ST	= .2561-02	PHI	= .00
	CF/2	= .0000	EMIS	= .8500
	TAU W	= .1500-01	ALPHA	= 90.00
	DELTA	= .0000	BETA	= 90.00
	DEL *	= .0000		
	THETA	= .0000	LEWIS	= 1.351
			HDS	= 28.

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1604-01	.2204+03	.2212+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TURBULENT	.0000	.2204+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	PCT	= .000
	PARA	=.0000
	RET/ML	=.0000
	RE E	=.0000

	Q	Q TOT
CONV	.221	1822.
RAD EQ	.221	1822.
RAD	.221	
NET	.000	0.
CW	3.536	4015.

HC(H)= .1604-01 H RECOV = 220.5
HC(T)= .4102-02 T RECOV = 454.
T RAD EQ= 400.

TDOT = .000

IT = 121

TEMPERATURE (DEG F) = 400.32

QC MAX 13.52 TIME= 110.
TW MAX= 1945. TIME= 110.

TRAJECTORY (RTLS-EX) 32779 BODY POINT (BP) 1100 ICASE 3
MINIATURE VERSION OF JA70 (MINIVER)

TIMING

T1	=	.000
DT1	=	25.000
T2	=	300.000
DT2	=	.000
T3	=	.000
DT3	=	.000
T4	=	.000
DT CALC	=	.100
DTEMP MAX	=	10.000

HEAT TRANSFER

HT METHOD	=	1.000
RN	=	1.000
L	=	.000
N SUB L	=	1.000
N SUB T	=	1.000
PHI	=	.000
VIRT.L OPT	=	.000

MULTIPLICATION FACTORS

K SUB L 1	=	1.000
K SUB T 1	=	1.000
H FAC	=	1.000

MATERIAL

MATL NO.	=	.000
THICKNESS	=	1.839
EMISSIVITY	=	.850
INIT TEMP	=	150.000
DENSITY	=	10000.000
SP. HEAT	=	10000.000

FLOWFIELD

	FLAG	ANGLE
1	3E.	90.00
2	1E.	90.00

TRANSITION
OPTION
TRAJECTORY

TIME	ALTITUDE	VELOCITY	ALPHA
.00	240000.	9300.0	50.000
25.00	230000.	9350.0	50.000
50.00	202000.	9200.0	50.000
75.00	163000.	8800.0	50.000
100.00	133000.	7900.0	23.000
110.00	124000.	7600.0	18.000
125.00	117000.	7200.0	16.000
150.00	110000.	6500.0	16.000
175.00	107000.	5700.0	16.000

200.00	104000.	4900.0	19.000
225.00	99000.	4200.0	19.500
250.00	94000.	3300.0	17.500
300.00	82000.	2500.0	12.000

1962 ICAO ATMOSPHERE

TIME= 0. Z= 240000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9300.	5.62	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2863-06
O			.6872+03	9.074	1.1261	1616.	4197.	.1067-05	.1487-05
U		5.62	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2863-06
D	1011.	.33	.6891+03	8.536	1.1259	1795.	4173.	.1010-05	.1482-05
E	0.	.00	.1686-11	9.074	1.1261	1816.	4197.	.1067-05	.1487-05
W		X L=	.0000	C P= 1.896	1.3620	322.	850.	.4032-05	.7135-06
*			.0000		1.2403	0.	-460.	.0000	.0000

	H	HP	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.2509-02	.1816+04	.1191+01	1.000	.274	1.000	.274	1.000	1.000	1.000
TURBULENT	.0000	.1816+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	1.192	0.
RAD EQ	1.192	0.
RAD	1.192	
NET	.000	0.
CH	1.447	0.

HC(H)= .7970-03 H RECOV = 1815.8
HC(T)= .3561-03 T RECOV = 4197.
T RAD EQ= 850.

TEMPERATURE (DEG F) = 850.37

R	= 1.000
L	= .0000
PHI	= .00
EMIS	= .8500
ALPHA	= 90.00
BETA	= 90.00
LEWIS	= 1.350
NDS	= 1072.
PCT	= .000
PARA	=.0000
RET/ML	=.0000
RE E	=.0000
TDOT	= .000
IT	= 1

S/R	= 39.61
PR	= .7100
ST	= .2425-01
CF/2	= .0000
TAU W	= .5815-16
DELTA	= .0000
DEL *	= .0000
THETA	= .0000

22-9

TIME= 25. Z= 230000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9350.	5.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06
O			.1043+04	13.85	1.1289	1840.	4275.	.1601-05	.1501-05
U		5.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06
D	1024.	.33	.1046+04	13.15	1.1287	1819.	4255.	.1529-05	.1497-05
E	129.	.04	.1376+03	13.85	1.1289	1839.	4281.	.1600-05	.1501-05
W		X L=	.0000	C P= 1.877	1.3584	330.	912.	.5878-05	.7345-06
*			.0000		1.2155	0.	-460.	.0000	.0000

	H	HP	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.3491-02	.1840+04	.1433+01	1.000	.274	1.000	.274	1.000	1.000	1.000
TURBULENT	.0000	.1840+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	1.433	32.
RAD EQ	1.433	32.
RAD	1.433	
NET	.000	0.
CH	1.755	39.

HC(H)= .9539-03 H RECOV = 1839.6
HC(T)= .4256-03 T RECOV = 4279.
T RAD EQ= 912.

TEMPERATURE (DEG F) = 912.20

R	= 1.000
L	= .0000
PHI	= .00
EMIS	= .8500
ALPHA	= 90.00
BETA	= 90.00
LEWIS	= 1.351
NDS	= 998.
PCT	= .000
PARA	=.0000
RET/ML	=.0000
RE E	=.0000
TDOT	= .000
IT	= 11

S/R	= 39.22
PR	= .7100
ST	= .1894-01
CF/2	= .0000
TAU W	= .3824-02
DELTA	= .0000
DEL *	= .0000
THETA	= .0000

TIME= 50. Z= 202000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9200.	8.80	.1333+05	.3813	1.4000	109.	-5.	.4884-06	.3370-06
O			.2951+04	39.28	1.1367	1798.	4400.	.4473-05	.1522-05
U		8.80	.1333+05	.3813	1.4000	109.	-5.	.4884-06	.3370-06
D	1062.	.34	.2962+04	36.90	1.1366	1776.	4372.	.4233-05	.1517-05
E	0.	.00	.5831-11	39.28	1.1367	1798.	4400.	.4473-05	.1522-05
W		X L= .0000	C P= 1.682	1.3487		380.	1077.	.1468-04	.7879-06
*			.3000		1.2260	0.	-460.	.0000	.0000

	M	MR	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5793-02	.1798+04	.2252+01	1.000	.274	1.000	.274	1.000	1.000	1.000
TURBULENT	.0000	.1798+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	2.254	77.
RAD EQ	2.254	77.
RAD	2.254	
NET	.000	0.
CW	2.855	95.

HC(H)= .1587-02 H RECOV = 1798.5
HC(T)= .6781-03 T RECOV = 4400.
T RAD EQ= 1077.

TEMPERATURE (DEG F) = 1076.62

S/R = 38.02
PR = .7100
ST = .1098-01
CF/2 = .0000
TAU W = .1146-15
DELTA = .0000
DEL * = .0000
THETA = .0000
LEWIS = 1.352
MDS = 850.

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00

PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000

TDOT = .000

IT = 21

TIME= 75. Z= 163000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	8800.	8.13	.5124+05	1.733	1.4000	117.	27.	.2072-05	.3559-06
O			.1193+05	141.5	1.1547	1663.	4444.	.1741-04	.1529-05
U		8.13	.5124+05	1.733	1.4000	117.	27.	.2072-05	.3559-06
D	1107.	.35	.1198+05	141.9	1.1556	1638.	4405.	.1647-04	.1522-05
E	0.	.00	.2532-10	151.5	1.1547	1663.	4444.	.1741-04	.1529-05
W		X L= .0000	C P= 1.866	1.3393		436.	1283.	.5059-04	.8508-06
*			.0000		1.2489	0.	-460.	.0000	.0000

	H	MR	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1110-01	.1663+04	.3733+01	1.000	.274	1.000	.274	1.000	1.000	1.000
TURBULENT	.0000	.1663+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	3.733	149.
RAD EQ	3.733	149.
RAD	3.733	
NET	.000	0.
CW	5.056	189.

HC(H)= .3041-02 H RECOV = 1662.5
HC(T)= .1161-02 T RECOV = 4444.
T RAD EQ= 1283.

TEMPERATURE (DEG F) = 1283.23

S/R = 36.20
PR = .7100
ST = .5183-02
CF/2 = .0000
TAU W = .2099-15
DELTA = .0000
DEL * = .0000
THETA = .0000
LEWIS = 1.352
MDS = 547.

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00

PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000

TDOT = .000

IT = 31

TIME= 100. Z= 133000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	7600.	7.57	.1685+06	5.578	1.4006	109.	-6.	.7168-05	.3361-06
C			.3877+05	419.2	1.1961	1354.	4057.	.5344-04	.1462-05
U		7.57	.1685+06	5.578	1.4000	109.	-6.	.7168-05	.3361-06
D	1129.	.37	.3898+05	388.6	1.1985	1329.	4004.	.5016-04	.1453-05
E	264.	.69	.9672+04	419.2	1.1964	1353.	4054.	.5340-04	.1462-05
*		X L=	.0000	C P= 1.849	1.3428	409.	1188.	.1481-03	.8224-06
			.0000		1.2837	0.	-460.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.1853-01	.1354+04	.2982+01	1.000	.173	1.000	.173	1.000	1.000	1.000
TURBULENT	.0000	.1354+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	2.987	272.
RAD EQ	2.987	232.
RAD	2.987	
NET	.000	0.
CW	4.272	305.

HC(H)= .3154-02 H RECOV = 1354.4
HC(T)= .1040-02 T RECOV = 4057.
T RAD EQ= 1188.

S/R = 34.21
PR = .7100
ST = .1731-02
CF/2 = .0000
TAU W = .2589-01
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.352
MDS = 349.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TDOT = .000
IT = 41

TEMPERATURE (DEG F) = 1188.19

TIME= 125. Z= 117000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	7200.	7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06
C			.7760+05	727.2	1.2409	1138.	3562.	.1048-03	.1372-05
U		7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06
D	1101.	.38	.7851+05	661.6	1.2451	1113.	3496.	.9701-04	.1360-05
E	0.	.00	.1389-09	727.2	1.2409	1138.	3562.	.1048-03	.1372-05
*		X L=	.0000	C P= 1.864	1.3433	405.	1174.	.2591-03	.8182-06
			.0000		1.2981	0.	-460.	.0000	.0000

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.2172-01	.1138+04	.2884+01	1.000	.166	1.000	.166	1.000	1.000	1.000
TURBULENT	.0000	.1138+04	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	2.884	307.
RAD EQ	2.884	307.
RAD	2.884	
NET	.000	0.
CW	4.479	416.

HC(H)= .3937-02 H RECOV = 1137.6
HC(T)= .1208-02 T RECOV = 3562.
T RAD EQ= 1174.

S/R = 32.93
PR = .7100
ST = .1146-02
CF/2 = .0000
TAU W = .2224-15
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.352
MDS = 255.
PCT = .000
PARA = .0000
RET/ML = .0000
RE E = .0000
TDOT = .000
IT = 51

TEMPERATURE (DEG F) = 1174.40

TIME= 150. Z= 110000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	6500.	6.48	.4265+06	14.84	1.4000	100.	-41.	.2066-04	.3149-06
O			.1060+06	817.6	1.2770	944.	3015.	.1368-03	.1267-05
U		6.48	.4265+06	14.84	1.4000	100.	-41.	.2066-04	.3149-06
D	1055.	.39	.1072+06	745.7	1.2795	921.	2950.	.1273-03	.1253-05
E	0.	.00	.1773-09	817.6	1.2770	944.	3015.	.1368-03	.1267-05
W		X L=	.0000 C	P= 1.839	1.3481	382.	1087.	.3077-03	.7912-06
*			.0000		1.3099	0.	-460.	.0000	.0000

	H	HR	GC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.2485-01	.9437+03	.2315+01	1.000	.166	1.000	.166	1.000	1.000	1.000
TURBULENT	.0000	.9437+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	2.316	373.
RAD EQ	2.316	373.
RAD	2.316	
NET	.000	0.
CW	3.892	521.

HC(H)= .4125-02 H RECOV = 543.7
HC(T)= .1199-02 T RECOV = 3019.
T RAD EQ= 1087.

TEMPERATURE (DEG F) = 1087.22

S/R = 32.05
PR = .7100
ST = .9548-03
CF/2 = .0000
TAU W = .3103-15
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.351
MOS = 191.
PCT = .000
PARA = .0000
RET/PL = .0000
RE E = .0000
TDOT = .000
IT = 61

TIME= 175. Z= 107000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	5700.	5.72	.4361+06	16.96	1.4000	99.	-46.	.2387-04	.3120-06
O			.1201+06	731.1	1.3007	748.	2391.	.1493-03	.1133-05
U		5.72	.4361+06	16.96	1.4000	99.	-46.	.2367-04	.3120-06
D	990.	.41	.1217+06	657.2	1.3029	728.	2323.	.1375-03	.1118-05
E	0.	.00	.1896-09	731.1	1.3007	748.	2391.	.1493-03	.1133-05
W		X L=	.0000 C	P= 1.841	1.3565	346.	943.	.3033-03	.7449-06
*			.0000		1.3239	0.	-460.	.0000	.0000

	H	HR	GC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.2316-01	.7478+03	.1567+01	1.000	.168	1.000	.168	1.000	1.000	1.000
TURBULENT	.0000	.7478+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	1.568	422.
RAD EQ	1.568	422.
RAD	1.568	
NET	.000	0.
CW	2.913	607.

HC(H)= .3895-02 H RECOV = 747.8
HC(T)= .1083-02 T RECOV = 2391.
T RAD EQ= 943.

TEMPERATURE (DEG F) = 943.48

S/R = 31.27
PR = .7100
ST = .8896-03
CF/2 = .0000
TAU W = .1742-15
DELTA = .0000
DEL * = .0000
THETA = .0000

R = 1.000
L = .0000
PHI = .00
EMIS = .8500
ALPHA = 90.00
BETA = 90.00
LEWIS = 1.351
MOS = 147.
PCT = .000
PARA = .0000
RET/PL = .0000
RE E = .0000
TDOT = .000
IT = 71

TIME= 200. Z= 104000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 30.44	R = 1.000
I	4900.	4.93	.4350+06	19.41	1.4000	99.	-45.	.2753-04	.3101-06	PR = .7100	L = .0000
O			.1360+06	630.3	1.3200	578.	1795.	.1624-03	.9917-06	ST = .8236-03	PHI = .00
U		4.93	.4350+06	19.41	1.4000	99.	-45.	.2753-04	.3101-06	CF/2 = .0000	EMIS = .8500
D	916.	.41	.1362+06	555.8	1.3223	561.	1737.	.1472-03	.9759-06	TAU W = .1374-15	ALPHA = 90.00
E	0.	.00	.2027-09	630.3	1.3200	578.	1795.	.1624-03	.9917-06	DELTA = .0000	BETA = 90.00
W		X L=	.0000	C P= 1.848	1.3658	305.	786.	.2945-03	.6910-06	DEL * = .0000	
*			.0000		1.3381	0.	-460.	.0000	.0000	THETA = .0000	LEWIS = 1.351
											MDS = 109.

	M	HS	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.2115-01	.5778+03	.9742+00	1.000	.169	1.000	.169	1.000	1.000	1.000
TURBULENT	.0000	.5778+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .000
PARA = .0000
RET/PL = .0000
RE E = .0000

	C	Q TOT				
CONV	.974	454.	HC(H)= .3575-02	H RECOV =	577.8	
RAD EQ	.974	454.	HC(T)= .9617-03	T RECOV =	1799.	
RAD	.974			T RAD EQ=	786.	
NET	.000	0.				
CW	2.066	670.				

TDCT = .000

IT = 81

TEMPERATURE (DEG F) = 786.04

TIME= 225. Z= 99000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 29.59	R = 1.000
I	4200.	4.24	.4735+06	24.35	1.4000	98.	-52.	.3477-04	.3084-06	PR = .7100	L = .0000
O			.1685+06	571.7	1.3372	450.	1337.	.1852-03	.8665-06	ST = .7112-03	PHI = .00
U		4.24	.4735+06	24.35	1.4000	98.	-52.	.3477-04	.3084-06	CF/2 = .0000	EMIS = .8500
D	853.	.43	.1716+06	512.8	1.3392	435.	1284.	.1712-03	.8511-06	TAU W = .1101-15	ALPHA = 90.00
E	0.	.00	.2268-09	571.7	1.3372	450.	1337.	.1852-03	.8665-06	DELTA = .0000	BETA = 90.00
W		X L=	.0000	C P= 1.785	1.3740	269.	646.	.3011-03	.6397-06	DEL * = .0000	
*			.0000		1.3528	0.	-460.	.0000	.0000	THETA = .0000	LEWIS = 1.351
											MDS = 76.

	M	HS	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.1971-01	.4500+03	.8038+00	1.000	.170	1.000	.170	1.000	1.000	1.000
TURBULENT	.0000	.4500+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .000
PARA = .0000
RET/PL = .0000
RE E = .0000

	C	Q TOT				
CONV	.604	474.	HC(H)= .3341-02	H RECOV =	450.0	
RAD EQ	.604	474.	HC(T)= .8728-03	T RECOV =	1337.	
RAD	.604			T RAD EQ=	646.	
NET	.000	0.				
CW	1.504	715.				

TDCT = .000

IT = 91

TEMPERATURE (DEG F) = 645.53

TIME= 260. Z= 94000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	3306.	3.34	.4732+06	30.60	1.4006	97.	-54.	.4398-04	.3067-06
C			.2062+06	460.1	1.3636	315.	622.	.2089-03	.7038-06
L		3.34	.4732+06	30.60	1.4000	97.	-54.	.4398-04	.3067-06
D	777.	.46	.2112+06	396.3	1.3664	302.	775.	.1868-03	.6671-06
E	0.	.00	.2474-09	460.1	1.3636	315.	622.	.2089-03	.7038-06
W		X L=	.0000 C P= 1.794		1.3857	219.	448.	.2953-03	.5609-06
*			.0000		1.3741	0.	-460.	.0000	.0000

	S/R	=	28.39	R	=	1.000
	PR	=	.7100	L	=	.0000
	ST	=	.6118-03	PHI	=	.00
	CF/2	=	.0000	EMIS	=	.8500
	TAU W	=	.7396-16	ALPHA	=	90.00
	DELTA	=	.0000	BETA	=	90.00
	DEL *	=	.0000			
	THETA	=	.0000	LEWIS	=	1.351
				MDS	=	46.

	M	MR	GC	K1	K2	K3	K	MFAC	MFAC1	MFAC2
LAMINAR	.1706-01	.3146+03	.2740+00	1.000	.168	1.000	.168	1.000	1.000	1.000
TURBULENT	.0000	.3146+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT				
CONV	.274	485.	HC(H)= .2857-02	H RECOV =	314.6	
RAD EQ	.274	485.	HC(T)= .7307-03	T RECOV =	822.	
RAD	.274			T RAD EQ=	448.	
NET	.000	0.				
CS	.859	746.				

PCT	.000
PARA	.0000
RET/RL	.0000
RE E	.0000
TDOT	.000
IT	101

TEMPERATURE (DEG F) = 443.60

6-27

TIME= 275. Z= 88000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	2900.	2.95	.5563+06	40.33	1.4000	96.	-58.	.5844-04	.3047-06
C			.2661+06	463.7	1.3752	264.	626.	.2486-03	.6323-06
L		2.95	.5563+06	40.33	1.4000	96.	-58.	.5844-04	.3047-06
D	750.	.48	.2755+06	404.4	1.3778	253.	582.	.2260-03	.6153-06
E	82.	.05	.3245+05	463.7	1.3752	264.	625.	.2486-03	.6321-06
W		X L=	.0000 C P= 1.743		1.3903	197.	363.	.3282-03	.5244-06
*			.0000		1.3827	0.	-460.	.0000	.0000

	S/R	=	27.76	R	=	1.000
	PR	=	.7100	L	=	.0000
	ST	=	.5054-03	PHI	=	.00
	CF/2	=	.0000	EMIS	=	.8500
	TAU W	=	.7057-02	ALPHA	=	90.00
	DELTA	=	.0000	BETA	=	90.00
	DEL *	=	.0000			
	THETA	=	.0000	LEWIS	=	1.351
				MDS	=	34.

	M	MR	GC	K1	K2	K3	K	MFAC	MFAC1	MFAC2
LAMINAR	.1673-01	.2643+03	.1856+00	1.000	.165	1.000	.165	1.000	1.000	1.000
TURBULENT	.0000	.2643+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT				
CONV	.185	491.	HC(H)= .2756-02	H RECOV =	264.3	
RAD EQ	.185	491.	HC(T)= .7030-03	T RECOV =	626.	
RAD	.185			T RAD EQ=	363.	
NET	.000	0.				
CS	.728	766.				

PCT	.000
PARA	.0000
RET/RL	.0000
RE E	.0000
TDOT	.000
IT	111

TEMPERATURE (DEG F) = 362.69

TIME= 300. Z= .2000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	2500.	2.55	.6432+06	53.29	1.4000	96.	-61.	.7785-04	.3026-06
G			.3452+06	452.9	1.3853	220.	454.	.2864-03	.5638-06
U		2.55	.6432+06	53.29	1.4000	96.	-61.	.7785-04	.3026-06
D	735.	.51	.3566+06	396.6	1.3878	210.	412.	.2648-03	.5459-06
E	30.	.02	.1541+05	452.9	1.3853	220.	454.	.2885-03	.5637-06
W		A L=	.0000	C P= 1.643	1.3924	176.	273.	.3596-03	.4836-06
*			.0000		1.3901	0.	-460.	.0000	.0000

	M	HR	CC	H1	H2	H3	H	HFAC	HFAC1	HFAC2
LAMINAR	.1612-01	.2204+03	.1169+00	1.000	.162	1.000	.162	1.000	1.000	1.000
TURBULENT	.0000	.2204+03	.0000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	.117	495.
RAD EQ	.117	495.
RAD	.117	
NET	.000	0.
CB	.576	783.

MC(M)= .2611-02 H RECOV = 220.5
MC(T)= .6463-03 T RECOV = 454.
T RAD EQ= 273.

TEMPERATURE (DEG F) = 273.00

CC MAX= 3.73 TIME= 75.
TB MAX= 1263. TIME= 75.

S/R =	27.24
PR =	.7100
ST =	.4170-03
CF/2 =	.0000
TAU W =	.2441-02
DELTA =	.0000
DEL * =	.0000
THETA =	.0000

R =	1.000
L =	.0000
PHI =	.00
EMIS =	.8500
ALPHA =	90.00
BETA =	90.00
LEWIS =	1.351
MDS =	28.
PCT =	.000
PARA =	.0000
RET/ML =	.0000
RE E =	.0000
TDOT =	.000
IT =	121

TRAJECTORY (RTLS-EX) 3277P BODY POINT (BP) 1400 ICASE 4
MINIATURE VERSION OF JA70 (MINIVER)

TIMING
T1	=	.000
DT2	=	29.000
T2	=	300.000
DT2	=	.000
T3	=	.000
DT3	=	.000
T4	=	.000
DT CALC	=	.100
DTEMP MAX	=	10.000

HEAT TRANSFER
HT METHOD	=	4.000
RN	=	.000
L	=	43.127
N SUB L	=	1.000
N SUB T	=	1.000
PHI	=	1.230
VIRT.L OPT	=	.000

MULTIPLICATION FACTORS
K SUB L 1	=	1.000
K SUB T 1	=	1.000
M FAC	=	1.000

MATERIAL
MATL NO.	=	.000
THICKNESS	=	1.620
EMISSIVITY	=	.850
INIT TEMP	=	150.000
DENSITY	=	10000.000
SP. HEAT	=	10000.000

FLOWFIELD
	FLAG	ANGLE
1	36.	.00
2	10.	.00

TRANSITION
OPTION
R. I. TRANSITION CRITERION
B — LAMINAR BELOW AN RE THETA/ML (ALPHA)
TURBULENT ABOVE RE L = 2.0 X RE L BASED ON AN RE THETA/ML (ALPHA)
TRANSITIONAL BETWEEN THESE LIMITS

TRAJECTORY
TIME	ALTITUDE	VELOCITY	ALPHA
.00	240000.	9300.0	50.000
25.00	230000.	9350.0	50.000
50.00	220000.	9200.0	50.000
75.00	210000.	8600.0	50.000

100.00	133000.	7900.0	23.000
110.00	124000.	7600.0	18.000
125.00	113000.	7200.0	16.000
150.00	110000.	6500.0	16.000
175.00	107000.	5700.0	18.000
200.00	104000.	4900.0	19.000
225.00	99000.	4200.0	19.500
250.00	94000.	3300.0	17.500
300.00	82000.	2500.0	12.000

1962 ICAO ATMOSPHERE

TIME= 0. Z= 240000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R	= 38.31	R	= .0000
										PR	= .7717	L	= 43.13
I	9300.	9.82	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2863-06	ST	= .2962-02	PHI	= 1.23
O			.6728+03	31.17	1.1349	1616.	4382.	.3552-05	.1518-05	CF/2	= .2357-02	EMIS	= .8500
U		9.82	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2863-06				
D	5124.	1.78	.3033+04	5.697	1.1582	1291.	3645.	.8213-06	.1388-05	TAU W	= .5117-01	ALPHA	= 51.23
E	5044.	1.74	.3100+04	6.156	1.1608	1308.	3655.	.2540-06	.1390-05	DELTA	= .6042	BETA	= 57.36
W		X L=	.1337+06	C P= 1.281	1.3740	269.	646.	.3242-05	.6398-06	DEL *	= .2079		
*			.4926+04		1.2869	822.	2632.	.1159-05	.1186-05	THETA	= .0331	LEWIS	= .000
												MOS	= 0.

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.1610-03	.1740+04	.6035+00	1.000	2.550	1.000	2.550	1.000	1.000	1.000
TURBULENT	.3568-03	.1755+04	.5895+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .000
PARA = 232.8
RET/ML = 58.77
RE E = .1337+06

	C	Q TOT
CONV	.604	0.
RAD EQ	.604	0.
RAD	.664	
NET	.000	0.
CW	.714	0.

HC(H) = .4105-03 H RECOV = 1739.7
HC(T) = .1757-03 T RECOV = 4085.
T RAD EQ = 646.

TDOT = .000

IT = 1

TEMPERATURE (DEG F) = 645.76

TIME= 25. Z= 230000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R	= 37.94	R	= .0000
										PR	= .7718	L	= 43.13
I	9350.	9.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06	ST	= .2360-02	PHI	= 1.23
O			.1022+04	47.23	1.1374	1640.	4462.	.5297-05	.1532-05	CF/2	= .1894-02	EMIS	= .8500
U		9.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06				
D	5130.	1.76	.4590+04	9.126	1.1596	1314.	3707.	.1252-05	.1399-05	TAU W	= .6295-01	ALPHA	= 51.23
E	5063.	1.74	.4690+04	9.498	1.1608	1328.	3715.	.1298-05	.1401-05	DELTA	= .4909	BETA	= 57.53
W		X L=	.2023+06	C P= 1.282	1.3706	285.	705.	.4748-05	.6616-06	DEL *	= .1690		
*			.6859+04		1.2636	901.	2652.	.1670-05	.1232-05	THETA	= .0266	LEWIS	= .000
												MOS	= 0.

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.1973-03	.1763+04	.7436+00	1.000	2.550	1.000	2.550	1.000	1.000	1.000
TURBULENT	.5807-03	.1778+04	.8674+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .000
PARA = 232.8
RET/ML = 71.71
RE E = .2023+06

	C	Q TOT
CONV	.744	17.
RAD EQ	.744	17.
RAD	.744	
NET	.000	0.
CW	.867	20.

HC(H) = .5031-03 H RECOV = 1762.8
HC(T) = .2150-03 T RECOV = 4164.
T RAD EQ = 705.

TDOT = .000

IT = 11

TEMPERATURE (DEG F) = 704.82

TIME= 50. Z= 202000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 36.86 / PR = .7719	R = .0000 / L = 43.13
I	9200.	8.80	.1333+05	.3813	1.4000	109.	-5.	.4884-06	.3370-06	ST = .1452-02	PHI = 1.23
G			.2900+04	119.0	1.1459	1798.	456E.	.1319-04	.1549-05	CF/2 = .1156-02	EMIS = .8500
U		8.80	.1333+05	.3813	1.4000	109.	-5.	.4884-06	.3370-06		
D	4964.	1.69	.1239+05	26.09	1.1709	1306.	3784.	.3526-05	.1413-05	TAU W = .1012+00	ALPHA = 51.23
E	4913.	1.67	.1260+05	26.98	1.1706	1317.	3795.	.3633-05	.1416-05	DELTA = .2975	BETA = 58.22
W		X L=	.5436+06	C P= 1.287	1.3623	320.	645.	.1204-04	.7117-06	DEL * = .1024	
*			.1867+05		1.2681	907.	2878.	.4705-05	.1238-05	THETA = .0162	LEWIS = .000
											HDS = 0.

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.3270-03	.1726+04	.1172+01	1.000	2.550	1.000	2.550	1.000	1.000	1.000
TURBULENT	.1378-02	.1741+04	.1958+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .000
PARA = 232.8
RET/ML = 122.6
RE E = .5436+06

	C	Q TOT		
CONV	1.173	40.	HC(H)= .8338-03	H RECOV = 1726.2
RAD EQ	1.173	40.	HC(T)= .3411-03	T RECOV = 4284.
RAD	1.173			T RAD EQ= 845.
NET	.000	0.		
CH	1.439	48.		

TDOT = .000

IT = 21

TEMPERATURE (DEG F) = 845.20

********** TRANSITION ONSET **********

TIME= 72. Z= 166900.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 35.37 / PR = .7721	R = .0000 / L = 43.13
I	8840.	8.17	.4440+05	1.495	1.4000	117.	27.	.1788-05	.3559-06	ST = .8036-03	PHI = 1.23
G			.1020+05	352.7	1.1624	1677.	4567.	.3972-04	.1550-05	CF/2 = .6395-03	EMIS = .8500
U		8.17	.4440+05	1.495	1.4000	117.	27.	.1788-05	.3559-06		
D	4704.	1.59	.4059+05	88.69	1.1951	1235.	3752.	.1214-04	.1407-05	TAU W = .1725+00	ALPHA = 51.23
E	4643.	1.57	.4128+05	91.69	1.1967	1246.	3755.	.1253-04	.1409-05	DELTA = .1629	BETA = 58.87
W		X L=	.1780+07	C P= 1.291	1.3527	362.	1008.	.3635-04	.7661-06	DEL * = .0000	
*			.6171+05		1.2787	882.	2817.	.1629-04	.1225-05	THETA = .0000	LEWIS = .000
											HDS = 0.

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5882-03	.1612+04	.1875+01	1.000	2.550	1.000	2.550	1.000	1.000	1.000
TURBULENT	.3869-02	.1625+04	.4886+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = .001
PARA = 232.8
RET/ML = 235.6
RE E = .1780+07

	C	Q TOT		
CONV	1.879	73.	HC(H)= .1503-02	H RECOV = 1612.1
RAD EQ	1.879	73.	HC(T)= .5685-03	T RECOV = 4314.
RAD	1.879			T RAD EQ= 1008.
NET	.000	0.		
CH	2.424	89.		

TDOT = .000

IT = 30

TEMPERATURE (DEG F) = 1008.43

TIME= 75. Z= 163000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	8600.	6.13	.5124+05	1.733	1.4006	117.	27.	.2072-05	.3559-06
O			.1177+05	403.3	1.1647	1663.	4562.	.4521-04	.1549-05
U		6.13	.5124+05	1.733	1.4000	117.	27.	.2072-05	.3559-06
D	4678.	1.58	.4669+05	101.9	1.1990	1225.	3736.	.1402-04	.1404-05
E	4630.	1.56	.4731+05	105.4	1.1969	1235.	3761.	.1440-04	.1409-05
W		X L=	.2040+07	C P= 1.291	1.3385	441.	1305.	.3476-04	.8570-06
*			.7107+05		1.2799	878.	2807.	.1878-04	.1223-05

	M	MR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.6301-03	.1598+04	.1866+01	1.000	2.550	1.000	2.550	1.000	1.000	1.000
TURBULENT	.4346-02	.1611+04	.5088+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT		
CONV	3.920	77.	HC(H)= .3363-02	H RECOV = 1606.6
RAD EQ	3.920	77.	HC(T)= .1298-02	T RECOV = 4325.
RAD	3.920			T RAD EQ= 1305.
NET	.000	0.		
CW	5.403	95.		

TEMPERATURE (DEG F) = 1304.62

	S/R	= 35.20
	PR	= .7324
	ST	= .1568-02
	CF/2	= .1248-02
	TAU W	= .3848+00
	DELTA	= .5592
	DEL *	= .0448
	THETA	= .0348

R	= .0000
L	= 43.13
PHI	= 1.23
EMIS	= .8500
ALPHA	= 51.23
BETA	= 58.91
LEWIS	= .000
HDS	= 0.
PCT	= .641
PARA	=.3454+07
RET/ML	=253.0
RE E	=.2040+07
TDOT	= .000
IT	= 31

TIME= 100. Z= 133000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	7900.	7.57	.1685+06	5.578	1.4000	109.	-6.	.7168-05	.3361-06
O			.3790+05	.1289+05	1.2346	1354.	4235.	.1591-02	.1494-05
U		7.57	.1685+06	5.578	1.4000	109.	-6.	.7168-05	.3361-06
D	7035.	3.79	.2895+06	81.00	1.3517	366.	1025.	.3175-04	.7716-06
E	7016.	3.75	.3019+06	86.66	1.3505	372.	1047.	.3349-04	.7784-06
W		X L=	.1302+08	C P= .362	1.3327	484.	1456.	.2629-04	.9010-06
*			.1443+06		1.3146	615.	1932.	.2109-04	.1025-05

	M	MR	QC	K1	K2	K3	K	HFAC	HFAC1	HFACZ
LAMINAR	.7516-03	.1207+04	.7691+00	1.000	1.412	1.000	1.412	1.000	1.000	1.000
TURBULENT	.7523-02	.1237+04	.5664+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT		
CONV	5.461	212.	HC(H)= .7291-02	H RECOV = 1235.5
RAD EQ	5.461	212.	HC(T)= .2390-02	T RECOV = 3752.
RAD	5.461			T RAD EQ= 1459.
NET	.000	0.		
CW	9.008	301.		

TEMPERATURE (DEG F) = 1458.90

	S/R	= 30.76
	PR	= .7122
	ST	= .9644-03
	CF/2	= .7675-03
	TAU W	= .1264+01
	DELTA	= .5809
	DEL *	= .0700
	THETA	= .0544

R	= .0000
L	= 43.13
PHI	= 1.23
EMIS	= .8500
ALPHA	= 24.23
BETA	= 27.84
LEWIS	= .000
HDS	= 0.
PCT	= .964
PARA	=.1482+08
RET/ML	=411.7
RE E	=.1302+08
TDOT	= .000
IT	= 41

********** FULLY TURBULENT **********

TIME= 110. Z= 124000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	7600.	7.39	.2488+06	8.101	1.4000	106.	-2C.	.1073-04	.3279-06
O			.5585+05	.3167+C5	1.2481	1258.	405C.	.4062-02	.1461-05
U		7.39	.2488+06	8.101	1.4000	106.	-2C.	.1073-04	.3279-06
D	7056.	4.40	.4523+06	75.75	1.3751	265.	627.	.4057-04	.6328-06
E	7038.	4.36	.4659+06	80.53	1.3740	270.	647.	.4237-04	.6401-06
W		X L=	.2009+08 C	P= .234	1.3337	476.	1433.	.2477-04	.8937-06
*			.1517+06		1.3216	566.	1757.	.2115-04	.9809-06

S/R = 29.58
PR = .7100
ST = .8148-03
CF/2 = .6484-03
TAU W = .1360+01
DELTA = .5525
DEL * = .0691
THETA = .0537

R = .0000
L = 43.13
PHI = 1.23
EMIS = .8500
ALPHA = 19.23
BETA = 22.67
LEWIS = .000
HDS = 0.

	H	HS	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.7405-03	.1110+04	.5593+CC	1.000	1.192	1.000	1.192	1.000	1.000	1.000
TURBULENT	.7816-02	.1140+04	.5185+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = 1.000
PARA = .1640+08
RET/ML = 502.5
RE E = .2009+08

	C	Q TOT
CONV	5.186	266.
RAD EQ	5.186	266.
RAD	5.186	
NET	.000	0.
CW	8.910	391.

HC(H)= .7818-02 H RECOV = 1139.7
HC(T)= .2494-02 T RECOV = 3512.
T RAD EQ= 1433.

TDOT = .000

IT = 45

TEMPERATURE (DEG F) = 1432.88

6-34

TIME= 125. Z= 117000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	7200.	7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06
O			.7682+05	.3564+05	1.2608	1138.	3656.	.5036-02	.1390-05
U		7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06
D	6778.	4.60	.5960+06	78.15	1.3853	221.	455.	.4975-04	.5639-06
E	6744.	4.49	.5996+06	84.00	1.3826	230.	49C.	.5146-04	.5787-06
W		X L=	.2586+08 C	P= .190	1.3352	465.	1391.	.2642-04	.8819-06
*			.1697+06		1.3272	524.	1605.	.2368-04	.9411-06

S/R = 29.00
PR = .7100
ST = .7535-03
CF/2 = .5996-03
TAU W = .1402+01
DELTA = .5253
DEL * = .0657
THETA = .0511

R = .0000
L = 43.13
PHI = 1.23
EMIS = .8500
ALPHA = 17.23
BETA = 20.69
LEWIS = .000
HDS = 0.

	H	HS	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.7513-03	.1001+04	.4451+00	1.000	1.104	1.000	1.104	1.000	1.000	1.000
TURBULENT	.8413-02	.1029+04	.4744+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = 1.000
PARA = .1714+08
RET/ML = 590.6
RE E = .2586+08

	C	Q TOT
CONV	4.744	341.
RAD EQ	4.744	341.
RAD	4.744	
NET	.000	0.
CW	8.655	523.

HC(H)= .8413-02 H RECOV = 1028.7
HC(T)= .2568-02 T RECOV = 3238.
T RAD EQ= 1391.

TDOT = .000

IT = 51

TEMPERATURE (DEG F) = 1390.84

TIME= 150. Z= 110000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	6500.	6.48	.4269+06	18.84	1.4000	100.	-41.	.2066-04	.3149-06
O			.1060+06	.2743+05	1.2806	944.	3019.	.4590-02	.1267-05
U		6.48	.4265+06	14.84	1.4000	100.	-41.	.2066-04	.3149-06
D	6114.	4.36	.7483+06	90.93	1.3902	198.	364.	.6425-04	.5250-06
E	6087.	4.29	.7648+06	98.29	1.3887	204.	390.	.6736-04	.5352-06
W		X L=	.3298+06 C P=	.191	1.3381	443.	1314.	.3227-04	.8596-06
*			.2113+06		1.3348	468.	1402.	.3073-04	.8852-06

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.7884-03	.8327+03	.3368+00	1.000	1.104	1.000	1.104	1.000	1.000	1.000
TURBULENT	.9721-02	.8549+03	.3999+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	3.999	452.
RAD EQ	3.999	452.
RAD	3.999	
NET	.000	0.
CW	8.311	736.

HC(H)= .9721-02 H RECOV = 854.9
HC(T)= .2811-02 T RECOV = 2736.
T RAD EQ= 1314.

TEMPERATURE (DEG F) = 1313.54

R	=	.0000							
L	=	43.13							
PHI	=	1.23							
EMIS	=	.8500							
ALPHA	=	17.23							
BETA	=	21.00							
LEWIS	=	.000							
HDS	=	0.							
PCT	=	1.000							
PARA	=	.1546+08							
RET/ML	=	702.2							
RE E	=	.3298+08							
TDOT	=	.000							
IT	=	61							

TIME= 175. Z= 107000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	5700.	5.72	.4361+06	16.96	1.4000	99.	-46.	.2387-04	.3120-06
O			.1201+06	.1912+05	1.3007	748.	2391.	.2883-02	.1133-05
U		5.72	.4361+06	16.96	1.4000	99.	-46.	.2387-04	.3120-06
D	5277.	3.61	.7494+06	100.7	1.3908	192.	342.	.7313-04	.5149-06
E	5256.	3.76	.7798+06	109.0	1.3901	196.	355.	.7754-04	.5227-06
W		X L=	.3363+08 C P=	.237	1.3434	404.	1172.	.3889-04	.8178-06
*			.2457+06		1.3427	409.	1190.	.3847-04	.8230-06

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.7503-03	.6651+03	.2495+00	1.000	1.192	1.000	1.192	1.000	1.000	1.000
TURBULENT	.1036-01	.6816+03	.2671+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	Q	Q TOT
CONV	2.871	539.
RAD EQ	2.871	539.
RAD	2.871	
NET	.000	0.
CW	7.061	930.

HC(H)= .1036-01 H RECOV = 681.6
HC(T)= .2901-02 T RECOV = 2162.
T RAD EQ= 1172.

TEMPERATURE (DEG F) = 1172.49

R	=	.0000							
L	=	43.13							
PHI	=	1.23							
EMIS	=	.8500							
ALPHA	=	19.23							
BETA	=	23.59							
LEWIS	=	.000							
HDS	=	0.							
PCT	=	1.000							
PARA	=	.1344+08							
RET/ML	=	760.7							
RE E	=	.3363+08							
TDOT	=	.000							
IT	=	71							

TIME= 200. Z= 104000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 27.94	R = .0000
										PR = .7100	L = 43.13
I	4500.	4.93	.4350+06	19.41	1.4006	99.	-45.	.2753-04	.3101-06	ST = .8386-03	PHI = 1.23
O			.1360+06	7745.	1.3200	578.	1795.	.1996-02	.9917-06	CF/2 = .6673-03	EMIS = .8500
U		4.93	.4350+06	19.41	1.4006	99.	-45.	.2753-04	.3101-06		
D	4490.	3.39	.7223+06	97.74	1.3925	175.	272.	.7772-04	.4831-06	TAU W = .1108+01	ALPHA = 20.23
E	4468.	3.34	.7582+06	107.0	1.3920	179.	286.	.8325-04	.4906-06	DELTA = .5012	BETA = 25.35
W		X L=	.3270+08	C P= .265	1.3542	356.	983.	.4317-04	.7578-06	DEL * = .0627	
*			.2643+06		1.3562	347.	950.	.4418-04	.7469-06	THETA = .0487	LEWIS = .000
											HDS = 0.

	H	HR	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.7439-03	.5180+03	.1494+00	1.000	1.236	1.000	1.236	1.000	1.000	1.000
TURBULENT	.1004-01	.5300+03	.1750+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = 1.000
PARA = .1103+08
RET/ML=827.7
RE E = .3270+08

	Q	Q TOT				
CONV	1.750	598.	HC(H)= .1004-01	H RECOV =	530.0	
RAD EQ	1.750	598.	HC(T)= .2720-02	T RECOV =	1626.	
RAD	1.750			T RAD EQ=	963.	
NET	.000	0.				
CW	5.319	1087.				

TDOT = .000

IT = 81

TEMPERATURE (DEG F) = 982.58

6-36

TIME= 225. Z= 99000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 27.51	R = .0000
										PR = .7100	L = 43.13
I	4200.	4.24	.4735+06	24.35	1.4000	98.	-52.	.3477-04	.3084-06	ST = .8777-03	PHI = 1.23
O			.1685+06	4611.	1.3372	450.	1339.	.1494-02	.8665-06	CF/2 = .6984-03	EMIS = .8500
U		4.24	.4735+06	24.35	1.4000	98.	-52.	.3477-04	.3084-06		
D	3822.	3.04	.7487+06	99.95	1.3982	158.	202.	.8795-04	.4490-06	TAU W = .9554+00	ALPHA = 20.73
E	3793.	2.97	.7879+06	111.1	1.3937	163.	220.	.9515-04	.4580-06	DELTA = .4974	BETA = 26.81
W		X L=	.3398+08	C P= .263	1.3643	312.	816.	.5088-04	.7000-06	DEL * = .0622	
*			.3004+06		1.3681	295.	747.	.5361-04	.6770-06	THETA = .0484	LEWIS = .000
											HDS = 0.

	H	HR	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.7187-03	.4069+03	.8596-01	1.000	1.258	1.000	1.258	1.000	1.000	1.000
TURBULENT	.1019-01	.4155+03	.1057+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = 1.000
PARA = .8789+07
RET/ML=965.5
RE E = .3398+08

	C	Q TOT				
CONV	1.057	633.	HC(H)= .1019-01	H RECOV =	415.5	
RAD EQ	1.057	633.	HC(T)= .2636-02	T RECOV =	1212.	
RAD	1.057			T RAD EQ=	812.	
NET	.000	0.				
CW	4.235	1208.				

TDOT = .000

IT = 91

TEMPERATURE (DEG F) = 811.64

TIME= 250. Z= 94000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	3300.	3.34	.4732+06	30.60	1.4000	97.	-54.	.4398-04	.3067-06
O			.2062+06	1720.	1.3636	315.	822.	.7809-03	.7038-06
L		3.34	.4732+06	30.60	1.4000	97.	-54.	.4398-04	.3067-06
D	3645.	2.67	.6536+06	77.34	1.3970	130.	82.	.8304-04	.3869-06
E	2593.	2.54	.6877+06	89.73	1.3964	136.	108.	.9201-04	.4007-06
W		X L=	.2964+08	C P= .247	1.3799	244.	546.	.5195-04	.6011-06
*			.2880+06		1.3836	228.	483.	.5540-04	.5757-06

	S/R	= 27.07
	PR	= .7100
	ST	= .9467-03
	CF/2	= .7533-03
	TAU W	= .6204+00
	DELTA	= .5112
	DEL *	= .0639
	THETA	= .0497

	R	= .0000
	L	= 43.13
	PHI	= 1.23
	EMIS	= .8500
	ALPHA	= 18.73
	BETA	= 27.03
	LEWIS	= .000
	MOS	= 0.

	H	HR	GC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5584-03	.2678+03	.3076-01	1.000	1.170	1.000	1.170	1.000	1.000	1.000
TURBULENT	.8388-02	.2932+03	.4135+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	PCT	= 1.000
	PARA	=.5449+07
	RET/PL	=1121.
	RE E	=.2964+08

	C	Q TOT				
CONV	.414	651.	HC(H)= .8388-02	H RECOV =	293.2	
RAD EQ	.414	651.	HC(T)= .2145-02	T RECOV =	739.	
RAD	.414			T RAD EQ=	546.	
NET	.000	0.				
CL	2.459	1292.				

	TDOT	= .000
	IT	= 101

TEMPERATURE (DEG F) = 545.83

6-37

TIME= 275. Z= 88000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	2900.	2.95	.5563+06	40.33	1.4000	96.	-58.	.5844-04	.3047-06
O			.2081+06	1244.	1.3752	264.	626.	.6669-03	.6323-06
L		2.95	.5563+06	40.33	1.4000	96.	-58.	.5844-04	.3047-06
D	2736.	2.54	.6863+06	73.25	1.3985	115.	22.	.8851-04	.3528-06
E	2717.	2.50	.7915+06	87.83	1.4000	117.	31.	.1043-03	.3578-06
W		X L=	.3414+06	C P= .193	1.3864	216.	436.	.5706-04	.5562-06
*			.3244+06		1.3904	196.	359.	.6243-04	.5228-06

	S/R	= 26.77
	PR	= .7100
	ST	= .9291-03
	CF/2	= .7393-03
	TAU W	= .5684+00
	DELTA	= .4969
	DEL *	= .0621
	THETA	= .0483

	R	= .0000
	L	= 43.13
	PHI	= 1.23
	EMIS	= .8500
	ALPHA	= 15.98
	BETA	= 26.22
	LEWIS	= .000
	MOS	= 0.

	H	HR	GC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5767-03	.2423+03	.1597-01	1.000	1.049	1.000	1.049	1.000	1.000	1.000
TURBULENT	.8466-02	.2467+03	.2609+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	PCT	= 1.000
	PARA	=.4120+07
	RET/PL	=1384.
	RE E	=.3414+08

	Q	Q TOT				
CONV	.261	660.	HC(H)= .8466-02	H RECOV =	246.7	
RAD EQ	.261	660.	HC(T)= .2164-02	T RECOV =	557.	
RAD	.261			T RAD EQ=	436.	
NET	.000	0.				
CL	2.068	1350.				

	TDOT	= .000
	IT	= 111

TEMPERATURE (DEG F) = 436.29

TIME= 300. Z= 82000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
T	2500.	2.55	.6432+06	53.29	1.4000	96.	-61.	.7785-04	.3026-06
O			.3452+06	974.4	1.3653	220.	454.	.5951-03	.5638-06
U		2.55	.6432+06	53.29	1.4000	96.	-61.	.7785-04	.3026-06
S	2396.	2.32	.7224+06	76.11	1.3994	106.	-15.	.9972-04	.3307-06
E	2362.	2.25	.7891+06	88.77	1.4000	109.	-1.	.1130-03	.3383-06
W		X/L=	.3403+08	C P= .146	1.3911	169.	327.	.6571-04	.5083-06
*			.3590+06		1.3928	172.	257.	.7211-04	.4758-06

	M	HR	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.8513-03	.2037+03	.7778-02	1.000	.928	1.000	.928	1.000	1.000	1.000
TURBULENT	.8344-02	.2071+03	.1547+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	.155	665.
RAD EQ	.155	665.
RAD	.155	
NET	.000	0.
CW	1.728	1398.

HC(H)= .8344-02 H RECOV = 207.1
HC(T)= .2056-02 T RECOV = 402.
T RAD EQ= 327.

TEMPERATURE (DEG F) = 326.76

CC MAX= 6.06 TIME= 92.
TW MAX= 1510. TIME= 92.

S/R = 26.52
PR = .7100
ST = .9713-03
CF/2 = .7730-03
TAU W = .4871+00
DELTA = .4972
DEL * = .0622
THETA = .0483

R = .0000
L = 83.13
PHI = 1.23
EMIS = .8500
ALPHA = 13.23
BETA = 27.25
LEWIS = .000
HDS = 0.
PCT = 1.000
PARA = .2551+07
RET/PL = 1756.
RE E = .3403+08
TDOT = .000
IT = 121

TRAJECTORY (RTLS-EX) 32779 BODY POINT (BP) 1750 ICASE 5
MINIATURE VERSION OF JA7C (MINIVER)

TIMING

T1	=	.000
DT1	=	25.000
T2	=	300.000
DT2	=	.000
T3	=	.000
DT3	=	.000
T4	=	.000
DT CALC	=	.100
DTEMP MAX	=	10.000

HEAT TRANSFER

HT METHOD	=	4.000
PR	=	.000
L	=	80.595
N SUB L	=	1.000
N SUB T	=	1.000
PHI	=	1.230
VIRT.L ORI	=	.000

MULTIPLICATION FACTORS

K SUB L 1	=	1.000
K SUB T 1	=	1.000
H FAC	=	1.000

MATERIAL

MATL NO.	=	.000
THICKNESS	=	1.232
EMISSIVITY	=	.850
WALL TEMP	=	150.000
DENSITY	=	10000.000
SP. HEAT	=	10000.000

FLOWFIELD

	FLAG	ANGLE
1	36.	.00
2	16.	.00

TRANSITION OPTION

8	R. I. TRANSITION CRITERION LAMINAR BELOW AN RE THETA/ML (ALPHA) TURBULENT ABOVE RE L = 2.0 x RE L BASED ON AN RE THETA/ML (ALPHA) TRANSITIONAL BETWEEN THESE LIMITS

TRAJECTORY

TIME	ALTITUDE	VELOCITY	ALPHA
.00	240000.	9300.0	50.000
25.00	230000.	9250.0	50.000
50.00	202000.	9200.0	50.000
75.00	183000.	8800.0	50.000

100.00	133000.	7900.0	23.000
114.00	124000.	7600.0	18.000
125.00	117000.	7200.0	16.000
150.00	110000.	6500.0	16.000
175.00	107000.	5700.0	18.000
200.00	104000.	4900.0	19.000
225.00	99000.	4200.0	19.500
250.00	94000.	3300.0	17.500
300.00	82000.	2500.0	12.000

1962 ICAO ATMOSPHERE

TIME= 0. Z= 2.0000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9300.	5.82	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2863-06
O			.6728+03	31.17	1.1349	1616.	4382.	.3552-05	.1518-05
U		5.82	.3569+04	.7037-01	1.4000	90.	-86.	.1098-06	.2663-06
D	5124.	1.78	.3033+04	5.897	1.1552	1291.	3645.	.8213-06	.1388-05
E	5044.	1.78	.3100+04	6.156	1.1608	1309.	3655.	.8540-06	.1390-05
W		X L=	.2498+06	C P= 1.261	1.2812	238.	525.	.3641-05	.5926-06
*			.4928+04		1.2669	822.	2632.	.1159-05	.1186-05

	H	HP	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1176-03	.1740+04	.3796+00	1.000	2.147	1.000	2.147	1.000	1.000	1.000
TURBULENT	.3621-03	.1755+04	.5491+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	.380	0.
RAD EQ	.360	0.
RAD	.380	
NET	.000	0.
C+	.440	0.

HC(H)= .2529-03 H RECOV = 1739.7
HC(T)= .1066-03 T RECOV = 4065.
T RAD EQ= 528.

TEMPERATURE (DEG F) = 524.05

	SAVE
S/R	= 38.31
PR	= .7717
ST	= .1825-02
CF/2	= .1452-02
TAU W	= .3152-01
DELTA	= .8259
DEL *	= .2843
THETA	= .0537

R	= .0000
L	= 80.60
PHI	= 1.23
EMIS	= .8500
ALPHA	= 51.23
BETA	= 57.36
LEWIS	= .000
HDS	= 0.
PCT	= .000
PAPA	=232.8
RET/ML	=95.39
RE E	=.2498+06
TOOT	= .000
IT	= 1

TIME= 25. Z= 230000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	9350.	5.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06
O			.1022+04	47.23	1.1378	1840.	4962.	.5297-05	.1532-05
U		5.60	.5218+04	.1134	1.4000	95.	-65.	.1674-06	.3000-06
D	5130.	1.76	.4590+04	9.126	1.1596	1314.	3707.	.1252-05	.1399-05
E	5063.	1.74	.4690+04	9.498	1.1608	1328.	3715.	.1298-05	.1401-05
W		X L=	.3780+06	C P= 1.282	1.3790	252.	-578.	.5326-05	.6139-06
*			.7005+04		1.2684	885.	2807.	.1692-05	.1223-05

	H	HP	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.1998-03	.1761+04	.9696+00	1.000	2.147	1.000	2.147	1.000	1.000	1.000
TURBULENT	.5276-03	.1778+04	.8051+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	.470	10.
RAD EQ	.470	10.
RAD	.470	
NET	.000	0.
C+	.548	12.

HC(H)= .3109-03 H RECOV = 1762.8
HC(T)= .1310-03 T RECOV = 4164.
T RAD EQ= 578.

TEMPERATURE (DEG F) = 578.37

	SAVE
S/R	= 37.94
PR	= .7718
ST	= .1470-02
CF/2	= .1170-02
TAU W	= .3890-01
DELTA	= .6711
DEL *	= .2310
THETA	= .0432

R	= .0000
L	= 80.60
PHI	= 1.23
EMIS	= .8500
ALPHA	= 51.23
BETA	= 57.53
LEWIS	= .000
HDS	= 0.
PCT	= .000
PAPA	=232.8
RET/ML	=116.8
RE E	=.3780+06
TOOT	= .000
IT	= 11

```
TIME=    50.      Z= 202000.

 VELOCITY     MACH      RE/FT       PRESSURE      GAMMA     ENTHALPY      TEMP        RHO          MU          S/R  =  36.86      R    =  .0000
                                                                                                                PR   =  .7719      L    =  8.60
I   9200.     6.60    .1333+05      .3813       1.4000       109.         -5.      .4884-06    .3370-06     ST   =  .8977-03   PHI  =  1.23
O                     .2900+04      116.0       1.1459      1798.       4565.     .1319-04    .1549-05     CF/2 =  .7143-03   EMIS =   .8500
U                6.80 .1333+05      .3813       1.4000       109.         -5.      .4884-06    .3370-06
C   4964.        1.69 .1239+05      26.09       1.1709      1306.       3784.     .3526-05    .1413-05     TAU W =  .6257-01   ALPHA =  51.23
E   4613.        1.67 .1260+05      26.98       1.1706      1317.       3795.     .3633-05    .1416-05     DEL TA =  .4067     BETA  =  50.22
W                X L= .1016+07 C P= 1.287      1.3706       284.        705.     .1349-04    .6617-06     DEL * =  .1400
*                     .1912+05                 1.2724       889.       2827.     .4778-05    .1227-05     THETA =  .0264      LEWIS =   .000
                                                                                                             HDS   =  0.

                  M          RE          QC          K1          K2          K3          K          HFAC        HFAC1       HFAC2
LAMINAR      .2400-03    .1726+04    .7431+00    1.000       2.147       1.000       2.147       1.000       1.000       1.000      PCT   =   .000
TURBULENT    .1261-02    .1741+04    .1836+01    1.003       1.000       1.000       1.000       1.000       1.000       1.000      PARA  =232.8
                                                                                                                                    RET/ML=199.7
                                                                                                                                    RE E  =.1016+07

             C       Q TOT
CONV         .744      25.      HC(H)= .5154-03  H RECOV = 1726.2
RAD EQ       .744      25.      HC(T)= .2078-03  T RECOV =  4264.
RAD          .744                                I RAD EQ=  705.
NET          .000       0.
CW           .850      29.                                                          IT   =  21

TEMPERATURE (DEG F) =   304.69

********** TRANSITION ONSET **********

TIME=    57.      Z= 190300.

 VELOCITY     MACH      RE/FT       PRESSURE      GAMMA     ENTHALPY      TEMP        RHO          MU          S/R  =  36.35      R    =  .0000
                                                                                                                PR   =  .7688      L    =  8L.60
I   9080.     6.57    .1998+05      .6081       1.4000       112.         -8.      .7579-06    .3444-06     ST   =  .8057-03   PHI  =  1.23
O                     .4435+04      173.2       1.1501      1756.       4575.     .1926-04    .1552-05     CF/2 =  .6411-03   EMIS =   .8500
U                6.57 .1998+05      .6081       1.4000       112.         -8.      .7579-06    .3444-06
C   4876.        1.65 .1844+05      39.54       1.1781      1283.       3788.     .5349-05    .1414-05     TAU W =  .8199-01   ALPHA =  51.23
E   4670.        1.63 .1875+05      40.86       1.1781      1294.       3801.     .5510-05    .1416-05     DEL TA =  .3323     BETA  =  58.45
W                X L= .1511+07 C P= 1.288      1.3662       JC4.        775.     .1920-04    .6887-06     DEL * =  .0041
*                     .2870+05                 1.2752       8P0.       2807.     .7283-05    .1223-05     THETA =  .0016      LEWIS =   .000
                                                                                                             HDS   =  0.

                  M          RE          QC          K1          K2          K3          K          HFAC        HFAC1       HFAC2
LAMINAR      .2530-03    .1688+04    .8711+00    1.000       2.147       1.000       2.147       1.000       1.000       1.000      PCT   =   .051
TURBULENT    .1790-02    .1702+04    .2503+01    1.000       1.000       1.000       1.000       1.000       1.000       1.000      PARA  =232.8
                                                                                                                                    RET/ML=249.1
                                                                                                                                    RE E  =.1511+07

             C       Q TOT
CONV         .954      31.      HC(H)= .6883-03  H RECOV = 1688.9
RAD EQ       .954      31.      HC(T)= .2710-03  T RECOV =  4298.
RAD          .954                                I RAD.EQ=  779.
NET          .000       0.
CW          1.162      37.                                                          IT   =  24

TEMPERATURE (DEG F) =   279.40

********** FULLY TURBULENT **********
```

TIME= 67. Z= 134700.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	8920.	6.27	.3370+05	1.112	1.4000	116.	25.	.1338-05	.3543-06
O			.7697+04	275.6	1.1578	1704.	4575.	.3089-04	.1551-05
U		6.27	.3370+05	1.112	1.4000	116.	25.	.1338-05	.3543-06
D	4757.	1.61	.3095+05	67.61	1.1378	1253.	3378.	.9189-05	.1412-05
E	4879.	1.59	.3169+05	69.82	1.1394	1269.	3418.	.9528-05	.1489-05
W		X L=	.2551+07	C P= 1.260	1.3406	425.	1246.	.2382-04	.8398-06
*			.4474+05		1.2698	924.	2935.	.1196-04	.1251-05

	M	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.3742-03	.1639+04	.9753+00	1.000	2.147	1.000	2.147	1.000	1.000	1.000
TURBULENT	.2793-02	.1652+04	.3427+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT	
CONV	3.427	53.	HC(M)= .2793-02 H RECOV = 1651.8
RAD EQ	3.427	53.	HC(T)= .1112-02 T RECOV = 4327.
GAM	3.427		T RAD EQ= 1246.
NET	.000	0.	
CB	4.619	65.	

TEMPERATURE (DEG F) = 1246.32

DELTA =1.5602
DEL * = .1950
THETA = .1517

R = .0000
L = 80.60
PHI = 1.23
EMIS = .8500
ALPHA = 51.23
BETA = 58.76
LEWIS = .000
NDS = 0.
PCT = 1.000
PARA =.2541+07
RET/ML=329.8
RE E =.2551+07
TDOT = .000
IT = 28

6-43

TIME= 75. Z= 163000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	8800.	6.13	.5124+05	1.733	1.4000	117.	27.	.2072-05	.3559-06
O			.1177+05	400.3	1.1647	1663.	4562.	.4521-04	.1509-05
U		6.13	.5124+05	1.733	1.4000	117.	27.	.2072-05	.3559-06
D	4678.	1.58	.4669+05	101.9	1.1990	1225.	3736.	.1402-04	.1404-05
E	4630.	1.56	.4731+05	105.4	1.1969	1235.	3761.	.1440-04	.1409-05
W		X L=	.3813+07	C P= 1.291	1.3360	455.	1371.	.3351-04	.8761-06
*			.6669+05		1.2720	924.	2941.	.1802-04	.1251-05

	M	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.4630-03	.1598+04	.1116+01	1.000	2.147	1.000	2.147	1.000	1.000	1.000
TURBULENT	.3542-02	.1611+04	.4541+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT	
CONV	4.541	81.	HC(M)= .3942-02 H RECOV = 1611.2
RAD EQ	4.541	81.	HC(T)= .1534-02 T RECOV = 4330.
GAM	4.54[illegible]		RAD EQ= 1371.
NET	.000	0.	
CB	6.352	104.	

TEMPERATURE (DEG F) = 1370.75

DELTA =1.4397
DEL * = .1808
THETA = .1400

R = .0000
L = 80.60
PHI = 1.23
EMIS = .8500
ALPHA = 51.23
BETA = 58.91
LEWIS = .000
NDS = 0.
PCT = 1.000
PARA =.2492+07
RET/ML=407.2
RE E =.3813+07
TDOT = .000
IT = 31

TIME= 190. Z= 133000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 30.76	R = .0000
										PR = .7100	L = 80.60
I	7990.	7.57	.1685+06	5.578	1.4000	109.	-6.	.7168-05	.3361-06	ST = .9183-03	PHI = 1.23
O			.3790+05	.1289+05	1.2346	1354.	4235.	.1591-02	.1494-05	CF/2 = .7276-03	EMIS = .8500
U		7.57	.1685+06	5.578	1.4000	109.	-6.	.7168-05	.3361-06		
D	7075.	3.79	.2895+06	81.00	1.3517	366.	1025.	.3175-04	.7716-06	TAU W = .1198+01	ALPHA = 24.23
E	7016.	3.75	.3019+06	86.66	1.3505	372.	1047.	.3349-04	.7784-06	DELTA = .9938	BETA = 27.84
W		X L=	.2433+08	C P= .362	1.3335	478.	1438.	.2658-04	.8952-06	DEL * = .1242	
*			.1436+06		1.3151	618.	1940.	.2102-04	.1027-05	THETA = .0966	LEWIS = .000
											HDS = 0.

	M	MF	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5516-03	.1207+04	.5186+00	1.000	1.290	1.000	1.290	1.000	1.000	1.000
TURBULENT	.6912-02	.1237+04	.5243+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = 1.000
PARA = .1234+08
RET/PL = 616.8
RE E = .2433+08

	C	Q TOT			
CONV	5.246	214.	HC(M)= .6912-02	H RECOV = 1236.5	
RAD EQ	5.246	214.	HC(T)= .2264-02	T RECOV = 3755.	
RAD	5.246			T RAD EQ= 1438.	
NET	.000	0.			
CW	8.547	348.			

TDOT = .000

IT = 41

TEMPERATURE (DEG F) = 1437.91

6-44

TIME= 125. Z= 117000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU	S/R = 29.00	R = .0000
										PR = .7100	L = 80.60
I	7200.	7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06	ST = .6928-03	PHI = 1.23
O			.7682+05	.3564+05	1.2608	1178.	3696.	.5036-02	.1390-05	CF/2 = .5513-03	EMIS = .8500
U		7.09	.3322+06	10.92	1.4000	103.	-31.	.1483-04	.3214-06		
D	6778.	4.60	.5980+06	78.15	1.3653	221.	455.	.4975-04	.5639-06	TAU W = .1289+01	ALPHA = 17.23
E	6744.	4.49	.5996+06	84.00	1.3824	230.	490.	.5146-04	.5787-06	DELTA = .8663	BETA = 20.69
W		X L=	.4833+08	C P= .190	1.3364	456.	1355.	.2668-04	.8729-06	DEL * = .1083	
*			.1718+06		1.3278	520.	1569.	.2396-04	.9368-06	THETA = .0842	LEWIS = .000
											HDS = 0.

	M	MF	CC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.4505-03	.1001+04	.3331+00	1.000	1.110	1.000	1.110	1.000	1.000	1.000
TURBULENT	.7735-02	.1029+04	.4429+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PCT = 1.000
PARA = .1726+08
RET/PL = 804.6
RE E = .4833+08

	C	Q TOT			
CONV	4.429	336.	HC(M)= .7735-02	H RECOV = 1026.7	
RAD EQ	4.429	336.	HC(T)= .2357-02	T RECOV = 3238.	
RAD	4.429			T RAD EQ= 1359.	
NET	.000	0.			
CW	7.957	511.			

TDOT = .000

IT = 51

TEMPERATURE (DEG F) = 1359.34

TIME= 150. Z= 110000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	6500.	6.48	.4265+06	14.84	1.4000	100.	-41.	.2066-04	.3149-06
O			.1060+06	.2743+05	1.2806	944.	3015.	.4590-02	.1267-05
U		6.48	.4265+06	14.84	1.4000	100.	-41.	.2066-04	.3149-06
D	6114.	4.36	.7483+06	90.93	1.3902	198.	364.	.6425-04	.5250-06
E	6097.	4.29	.7648+06	98.29	1.3887	204.	390.	.6736-04	.5362-06
W		X L=	.6164+08	C P= .191	1.3392	436.	1285.	.3279-04	.8513-06
*			.2139+06		1.3353	464.	1388.	.3097-04	.8611-06

	H	HR	GC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5777-03	.8327+03	.2545+00	1.000	1.110	1.000	1.110	1.000	1.000	1.000
TURBULENT	.8542-02	.8549+03	.3749+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	3.749	439.
RAD EQ	3.749	439.
RAD	3.749	
NET	.000	0.
CW	7.645	707.

HC(H)= .8942-02 H RECOV = 854.9
HC(T)= .2584-02 T RECOV = 2736.
T RAD EQ= 1265.

TEMPERATURE (DEG F) = 1265.14

S/R = 28.54
PR = .7100
ST = .6778-03
CF/2 = .5394-03
TAU W = .1345+01
DELTA = .8252
DEL * = .1031
THETA = .0802

R = .0000
L = 80.60
PHI = 1.23
EMIS = .8500
ALPHA = 17.23
BETA = 21.00
LEWIS = .000
MDS = 0.
PCT = 1.000
PARA = .1557+08
RET/ML = 956.6
RE E = .6164+08
TDOT = .000
IT = 61

TIME= 175. Z= 107000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	5700.	5.72	.4361+06	16.96	1.4000	99.	-46.	.2387-04	.3120-06
O			.1201+06	.1412+05	1.3007	748.	2391.	.2883-02	.1133-05
U		5.72	.4361+06	16.96	1.4000	99.	-46.	.2387-04	.3120-06
D	5277.	3.81	.7494+06	100.7	1.3908	192.	342.	.7313-04	.5149-06
E	5256.	3.76	.7798+06	109.0	1.3901	196.	355.	.7754-04	.5227-06
W		X L=	.6285+08	C P= .237	1.3445	358.	1148.	.3947-04	.8102-06
*			.2487+06		1.3432	406.	1178.	.3876-04	.8192-06

	H	HR	GC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5390-03	.6651+03	.1716+00	1.000	1.110	1.000	1.110	1.000	1.000	1.000
TURBULENT	.9530-02	.6816+03	.2703+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	2.705	521.
RAD EQ	2.705	521.
RAD	2.705	
NET	.000	0.
CW	6.496	886.

HC(H)= .9530-02 H RECOV = 681.6
HC(T)= .2668-02 T RECOV = 2162.
T RAD EQ= 1148.

TEMPERATURE (DEG F) = 1148.35

S/R = 28.31
PR = .7100
ST = .7268-03
CF/2 = .5784-03
TAU W = .1238+01
DELTA = .8220
DEL * = .1027
THETA = .0799

R = .0000
L = 80.60
PHI = 1.23
EMIS = .8500
ALPHA = 19.23
BETA = 23.59
LEWIS = .000
MDS = 0.
PCT = 1.000
PARA = .1161+08
RET/ML = 1119.
RE E = .6285+08
TDOT = .000
IT = 71

TIME= 200. Z= 104000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	4500.	4.93	.4350+06	19.41	1.4000	99.	-45.	.2753-04	.3101-06
C			.1360+06	7745.	1.3200	578.	1795.	.1996-02	.9917-06
U		4.93	.4350+06	19.41	1.4000	99.	-45.	.2753-04	.3101-06
O	4490.	3.39	.7223+06	97.74	1.3925	175.	272.	.7772-04	.4831-06
E	4468.	3.34	.7582+06	107.0	1.3920	179.	288.	.8325-04	.4906-06
W		X L=	.6111+08	C P= .265	1.3554	351.	963.	.4377-04	.7513-06
*			.2674+06		1.3568	345.	940.	.4450-04	.7436-06

	M	MR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5449-03	.9180+03	.1013+00	1.000	1.110	1.000	1.110	1.000	1.000	1.000
TURBULENT	.9230-02	.5300+03	.1656+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	1.656	576.
RAD EQ	1.656	576.
RAD	1.656	
NET	.000	0.
CW	4.892	1030.

HC(M)= .9230-02 H RECOV = 530.0
HC(T)= .2497-02 T RECOV = 1626.
T RAD EQ= 963.

TEMPERATURE (DEG F) = 962.83

S/R	=	27.94	R = .0000
PR	=	.7100	L = 80.60
ST	=	.7713-03	PHI = 1.23
CF/2	=	.6137-03	EMIS = .8500
TAU W	=	.1019+01	ALPHA = 20.23
DELTA	=	.8266	BETA = 25.35
DEL *	=	.1033	LEWIS = .000
THETA	=	.0804	MDS = 0.

PCT = 1.000
PARA = .8874+07
RET/ML =1262.
RE E =.6111+08

TDOT = .000

IT = 81

TIME= 225. Z= 99000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	4200.	4.24	.4735+06	24.35	1.4000	98.	-52.	.3477-04	.3084-06
C			.1665+06	4611.	1.3372	450.	1337.	.1494-02	.8665-06
U		4.24	.4735+06	24.35	1.4000	98.	-52.	.3477-04	.3084-06
O	3822.	3.04	.7487+06	99.95	1.3942	158.	202.	.8795-04	.4490-06
E	3793.	2.97	.7879+06	111.1	1.3937	163.	220.	.9515-04	.4580-06
W		X L=	.6350+08	C P= .283	1.3652	308.	797.	.5148-04	.6948-06
*			.3036+06		1.3685	293.	735.	.5396-04	.6742-06

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.5263-03	.4069+03	.5779-01	1.000	1.110	1.000	1.110	1.000	1.000	1.000
TURBULENT	.9371-02	.4155+03	.1008+01	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	1.008	610.
RAD EQ	1.008	610.
RAD	1.008	
NET	.000	0.
CW	3.894	1141.

HC(M)= .9371-02 H RECOV = 415.5
HC(T)= .2423-02 T RECOV = 1212.
T RAD EQ= 797.

TEMPERATURE (DEG F) = 796.63

S/R	=	27.51	R = .0000
PR	=	.7100	L = 80.60
ST	=	.8071-03	PHI = 1.23
CF/2	=	.6422-03	EMIS = .8500
TAU W	=	.8785+00	ALPHA = 20.73
DELTA	=	.8203	BETA = 26.81
DEL *	=	.1025	LEWIS = .000
THETA	=	.0797	MDS = 0.

PCT = 1.000
PARA =.6826+07
RET/ML =1467.
RE E =.6350+08

TDOT = .000

IT = 91

TIME= 250. Z= 94000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	3300.	3.34	.4732+06	30.60	1.4000	97.	-54.	.4398-04	.3067-06
C			.2062+06	1720.	1.3636	315.	822.	.7809-03	.7038-06
U		3.34	.4732+06	30.60	1.4000	97.	-54.	.4398-04	.3067-06
D	3045.	2.67	.6536+06	77.34	1.3970	130.	82.	.8304-04	.3669-06
E	2993.	2.56	.6873+06	89.73	1.3964	136.	108.	.9201-04	.4007-06
W		X/L=	.5539+08 C	P= .247	1.3805	241.	536.	.5244-04	.5974-06
*			.2906+06		1.3839	227.	478.	.5570-04	.5737-06

	H	HR	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.4381-03	.2878+03	.2253-01	1.000	1.110	1.000	1.110	1.000	1.000	1.000
TURBULENT	.7704-02	.2932+03	.3980+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	.398	627.
RAD EQ	.398	627.
RAD	.398	
NET	.000	0.
CH	2.259	1218.

HC(H)= .7704-02 H RECOV = 293.2
HC(T)= .1970-02 T RECOV = 739.
T RAD EQ= 536.

S/R	27.07
PR	.7100
ST	.8695-03
CF/2	.6919-03
TAU W	.5699+00
DELTA	.8430
DEL *	.1054
THETA	.0820

R	.0000
L	80.60
PHI	1.23
EMIS	.8500
ALPHA	18.73
BETA	27.03
LEWIS	.000
HDS	0.
PCT	1.000
PARA	.4894+07
RET/ML	1618.
RE E	.5539+08
TDOT	.000
IT	101

TEMPERATURE (DEG F) = 536.45

TIME= 275. Z= 88000.

	VELOCITY	MACH	RE/FT	PRESSURE	GAMMA	ENTHALPY	TEMP	RHO	MU
I	2900.	2.95	.5563+06	40.33	1.4000	96.	-58.	.5844-04	.3047-06
C			.2681+06	1244.	1.3752	264.	626.	.6669-03	.6323-06
U		2.95	.5563+06	40.33	1.4000	96.	-58.	.5844-04	.3047-06
D	2736.	2.54	.6863+06	73.25	1.3985	115.	22.	.8851-04	.3528-06
E	2717.	2.50	.7915+06	87.83	1.4000	117.	31.	.1043-03	.3578-06
W		X/L=	.6379+08 C	P= .193	1.3868	214.	430.	.5750-04	.5533-06
*			.3269+06		1.3905	195.	356.	.6272-04	.5212-06

	H	HP	QC	K1	K2	K3	K	HFAC	HFAC1	HFAC2
LAMINAR	.4222-03	.2423+03	.1317-01	1.000	1.109	1.000	1.109	1.000	1.000	1.000
TURBULENT	.7777-02	.2467+03	.2531+00	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	C	Q TOT
CONV	.253	635.
RAD EQ	.253	635.
RAD	.253	
NET	.000	0.
CH	1.918	1271.

HC(H)= .7777-02 H RECOV = 246.7
HC(T)= .1988-02 T RECOV = 557.
T RAD EQ= 430.

S/R	26.77
PR	.7100
ST	.8534-03
CF/2	.6791-03
TAU W	.5221+00
DELTA	.8195
DEL *	.1024
THETA	.0797

R	.0000
L	80.60
PHI	1.23
EMIS	.8500
ALPHA	15.98
BETA	26.22
LEWIS	.000
HDS	0.
PCT	1.000
PARA	.4602+07
RET/ML	1790.
RE E	.6379+08
TDOT	.000
IT	111

TEMPERATURE (DEG F) = 429.53

```
TIME=  300.      Z=  82000.

 VELOCITY     MACH      RE/FT        PRESSURE      GAMMA     ENTHALPY     TEMP        RHO          MU          S/R  =  26.52     R    = .0000
                                                                                                                FR   = .7100     L    = 80.60
I   2500.      2.65    .6432+06      53.29        1.4600       96.        -61.     .7785-04     .3026-06     ST   = .8922-03   PHI  =  1.23
C                      .3452+06      934.4        1.3853      220.        454.     .5951-03     .5638-06     CF/2 = .7100-03   EMIS =   .8500
U                2.55  .6432+06      53.29        1.4000       96.        -61.     .7785-04     .3026-06
D   2396.      2.32    .7224+06      76.11        1.3994      106.        -15.     .9972-04     .3307-06     TAU W = .4474+00  ALPHA =  13.23
E   2362.      2.25    .7891+06      80.77        1.4000      109.         -3.     .1130-03     .3383-06     DEL TA = .8200    BETA  =  27.25
W                X L= .6360+06 C P=   .146       1.3913      187.        322.     .6611-04     .5061-06     DEL * = .1025
*                      .3602+06                  1.3929      171.        254.     .7237-04     .4746-06     THETA = .0797     LEWIS =    .000
                                                                                                                               MOS   =     0.

                  H          HR          CC          K1          K2          K3          K          HFAC        HFAC1       HFAC2
LAMINAR       .4035-03    .2037+03    .7321-02    1.000       1.109       1.000       1.109       1.000       1.000       1.000          PCT  =  1.000
TURBULENT     .7664-02    .2071+03    .1510+00    1.000       1.000       1.000       1.000       1.000       1.000       1.000          PARA =.3641+07
                                                                                                                                    RET/ML=2009.
                                                                                                                                    RE E =.6360+08

                  C          Q TOT
CONV             .151        641.      HC(H)= .7664-02  H RECOV =  207.1
RAD EQ           .151        641.      HC(T)= .1886-02  T RECOV =  402.                                                          TDOT =    .000
RAD              .151                                   T RAD EQ=  322.
NET              .000          0.
CW              1.567       1315.                                                                                               IT   =  121

TEMPERATURE (DEG F) =   321.96

CC MAX=   5.65  TIME=    92.
TW MAX=  1474.  TIME=    92.

@PMP,E

@BRKPT
FIRST FILE NAME IS IN ERROR

@BRKPT PRINTS.
  14  ILLEGAL CHARACTER .

@BRKPT PRINTS
```

7. PLOT PACKAGE DESCRIPTION

MINIVER plots are generated using the DISSPLA utility routines as currently operational on the UNIVAC 1110 EXEC 8 operating system at the Johnson Space Center. All DISSPLA routines were not used to accomplish this task. Section 7.1 shows the subroutines used and gives a short explanation of the usage of each. For more detailed information, see the DISSPLA manuals (refs. 2 and 3). Several subroutines were written to drive these routines, PLOTLO (the main driver), HNDYLO, DRAWLO, DSMMLO, and PPLOTl. Description and usage of these subroutines is given in section 7.2. A detailed flowchart is shown in section 7.3. Output plots are shown in section 7.4.

7.1 USAGE OF DISSPLA ROUTINES

AXSPLT - To obtain rounded axis scaling parameters for units/inch (i.e., GRAPH type) axis

CALL AXSPLT(AMIN,AMAX,ORIG,STEP,AXIS)

AMIN - Least data value

AMAX - Greatest data value

ORIG - Returns rounded axis origin

STEP - Returns rounded step size

AXIS - Returns rounded minimum axis

BASALF - To obtain desired alphabet

CALL BASALF('STANDARD')

CURVE - To draw a curve

CALL CURVE(XARAY,YARAY,NPNTS, IMARK)

XARAY - Array containing X-values

YARAY - Array containing Y-values

NPNTS - Number of points to be plotted

IMARK - Frequency of marker symbol

> 0 Points connected with symbols

= 0 Points connected. No symbols

< 0 Points not connected

DISSPLA (automatically) allows up to 14 different symbols

ENDPL - To end a plot and create a new physical page

CALL ENDPL(IPLOT)

IPLOT is the plot number

> 0 Summary on printer and plot

= 0 No summary on either

< 0 Summary on plot only

ERASE - Erase screen contents

CALL ERASE

ERTRAN - To fetch current date and time

CALL ERTRAN(9,DATE,TIME)

The number 9 is required by the system. The other two arguments are self-explanatory.

GRACE - To set margin around the subplot area (beyond which curves will be scissored) to an arbitrary value. Default is 0.5 inch

CALL GRACE(GRACEM)

GRACEM - Width of grace margin around subplot area in inches

GRAPH - To set up linear axis specified in units/inch

CALL GRAPH(XORIG,XSTEP,YORIG,YSTEP)

XORIG - Value of X at the axis origin

XSTEP - X step size in units/inch

YORIG - Value of Y at the axis origin

YSTEP - Y step size in units/inch

GRID - To draw a grid in the subplotted area

CALL GRID(IXGRID,IYGRID)

IXGRID - Number of grid lines per X-axis step

IYGRID - Number of grid lines per Y-axis step

HEIGHT - To set character height. Default is 0.14 inch

CALL HEIGHT(HITE)

HITE - Character height in inches

INTNO - To plot an integer (in inches) from the physical origin

CALL INTNO(INUM,XPOS,YPOS)

INUM - Integer to be plotted as a string of digits

XPOS - X-coordinate in inches

YPOS - Y-coordinate in inches

IOWAIT - An interrupt to allow user viewing of display

CALL IOWAIT(IARG)

IARG - Number of seconds of image to remain on screen

LEGEND - Identifies the curves on a plot by their markers as provided by DISSPLA. The text for the legend must be supplied in an array which has been packed with the routine called LINES. The sequence of the lines should correspond to the order of use of the markers.

CALL LEGEND(IPKRAY,NLINES,XPOS,YPOS)

IPKRAY - Name of array containing packed lines

NLINES - Total number of curves to be identified

XPOS - X-distance from physical origin to lower left corner of legend, in inches

YPOS - Y-distance from physical origin to lower left corner of legend, in inches

LINES - To pack a line of text

CALL LINES(LSTRNG,IPKRAY,ILINE)

LSTRNG - Character string terminated by $

IPKRAY - Pack array to receive the line

INLINE - Sequence number of line being packed

MESSAG - To plot a message string, in inches from physical origin

CALL MESSAG(LMESS,IMESS,XPOS,YPOS)

LMESS - Characters to be written

IMESS - Number of characters in LMESS

XPOS - X-distance from physical origin to start of message, in inches

YPOS - Y-distance from physical origin to start of message, in inches

MIXALF - Refer to DISSPLA manuals (refs. 2 and 3)

NOCHEK - Suppress listing of points out of range. The default option is for the point out of range listed on the printer.

CALL NOCHEK

TEKEGM - DISSPLA interface with 1110 UNIVAC

CALL TEKEGM(480)

System expects the number 480

XINTAX - Integer numbering on X-axis

CALL XINTAX

YINTAX - Integer numbering of Y-axis

CALL YINTAX

YAXANG - Angle labels on Y-axis

CALL YAXANG(ANGLE)

ANGLE - Angle from horizontal, in degrees

7.2 MINIVER PLOT ROUTINES USAGE

PLOTLO - The driver routine for the plot package

```
CALL PLOTLO(TIME,NHFLAG,ARIDEF,ATRE,TZ,ZZ,VZ,ALFAOT,DELTAT,ITHICK,LNGPLT,
           TIN,MAXTME,DEVICE)
```

Argument in the call statement as defined in section 3.

Subroutines required: DRAWLO,DSMMLO,PPLOT1,HNDYLO

Libraries required : LOCALIB,DISSPLA,PLOT10

DRAWLO - A utility routine which collects DISSPLA routines that are called several times. The routine was written to avoid numerous calls to the same procedures.

```
CALL DRAWLO(XO,XD,XL,YO,YD,YL,XARRAY,YARRAY,NPOINT,IFLAG,IPASS)
```

XO - X-origin in inches

XD - X delta increments in inches

XL - X-axis range in inches

YO - Y origin in inches

YD - Y delta increments in inches

YL - Y-axis range in inches

XARRAY - X array to be plotted

YARRAY - Y array to be plotted

NPOINT - Number of X-Y pairs

IFLAY - To indicate closing of a given frame

IFLAG = 1 One plot per frame

IFLAG = 2 Two plots per frame

IFLAG = 3 First plot of a set of two

IPASS - Not used

Subroutines required: None

Libraries required : LOCALIB,DISSPLA,PLOT10

DSMMLO - Find minimum and maximum of an array

CALL DSMMLO(NP,A,YMIN,YMAX)

NP - Number of points

A - Array name

YMIN - Minimum value

YMAX - Maximum value

Subroutines required: None

Libraries required : None

HNDYLO - A utility routine to eliminate the calling of the same routines in the plot driver

CALL HNDYLO(XARRAY,YARRAY,NP,ILABL,IPASS)

XARRAY - X array to be plotted

YARRAY - Y array to be plotted

NP - Number of x,y pairs

ILABL - Y axis label (36 characters maximum)

IPASS - Not used

Subroutines required: PPLOT1,DSMMLO,DRAWLO

Libraries required : LOCALIB,DISSPLA,PLOT10

PPLOT1 - To place a label on the y-axis

CALL PPLOT1(ILABL,ICASE)

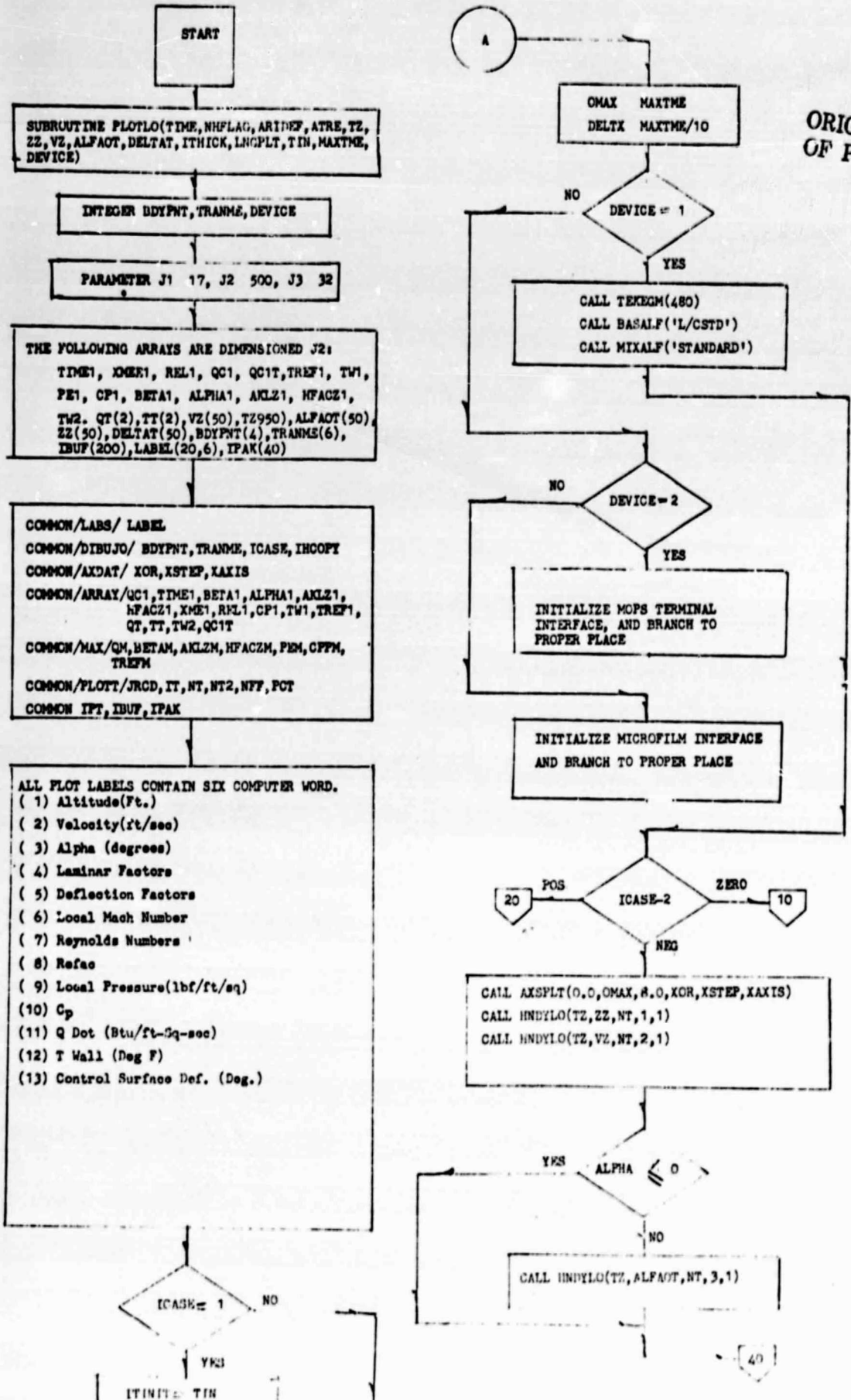
ILABL - Label to be used (36 characters maximum)

ICASE - Case number

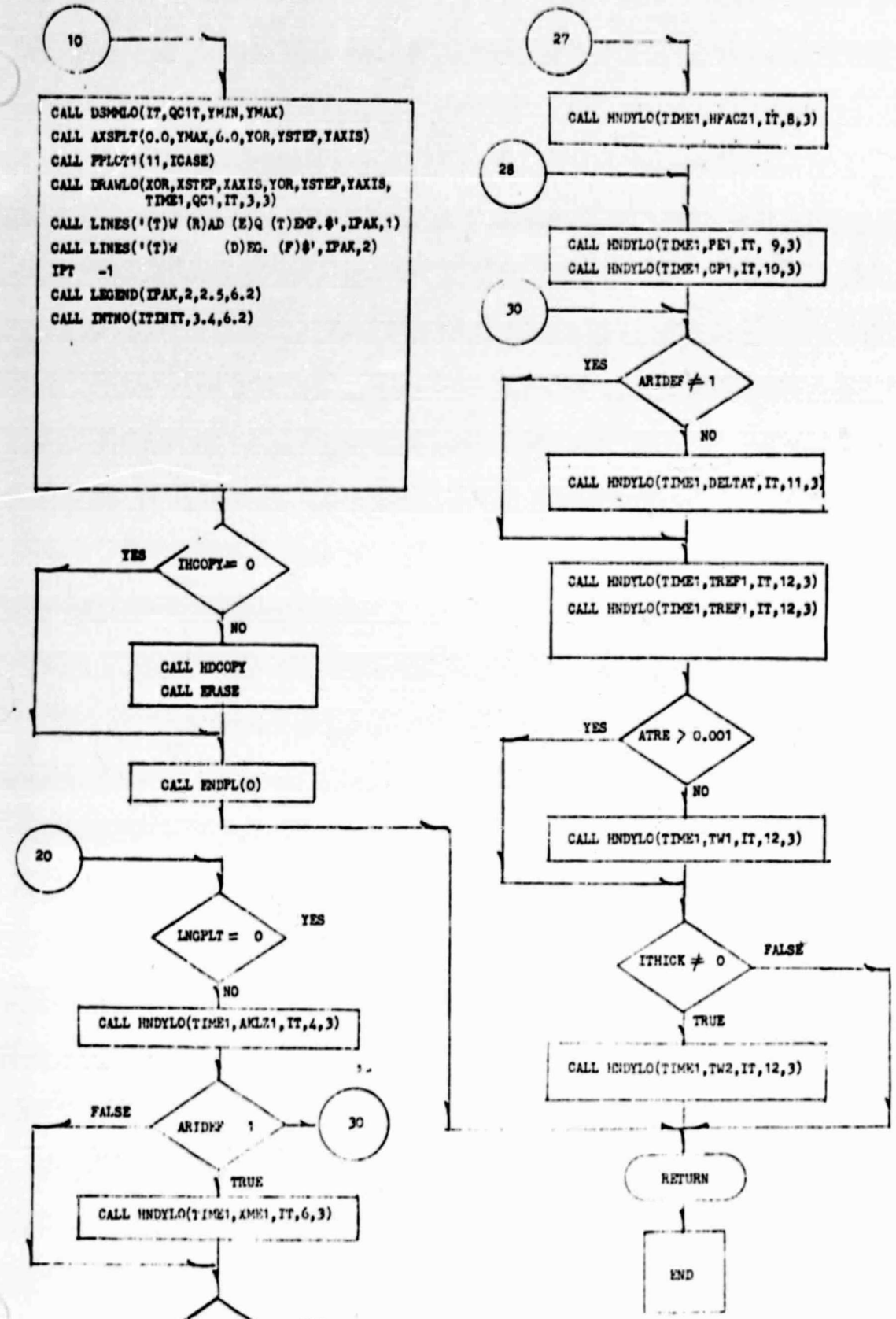
Subroutines required: None

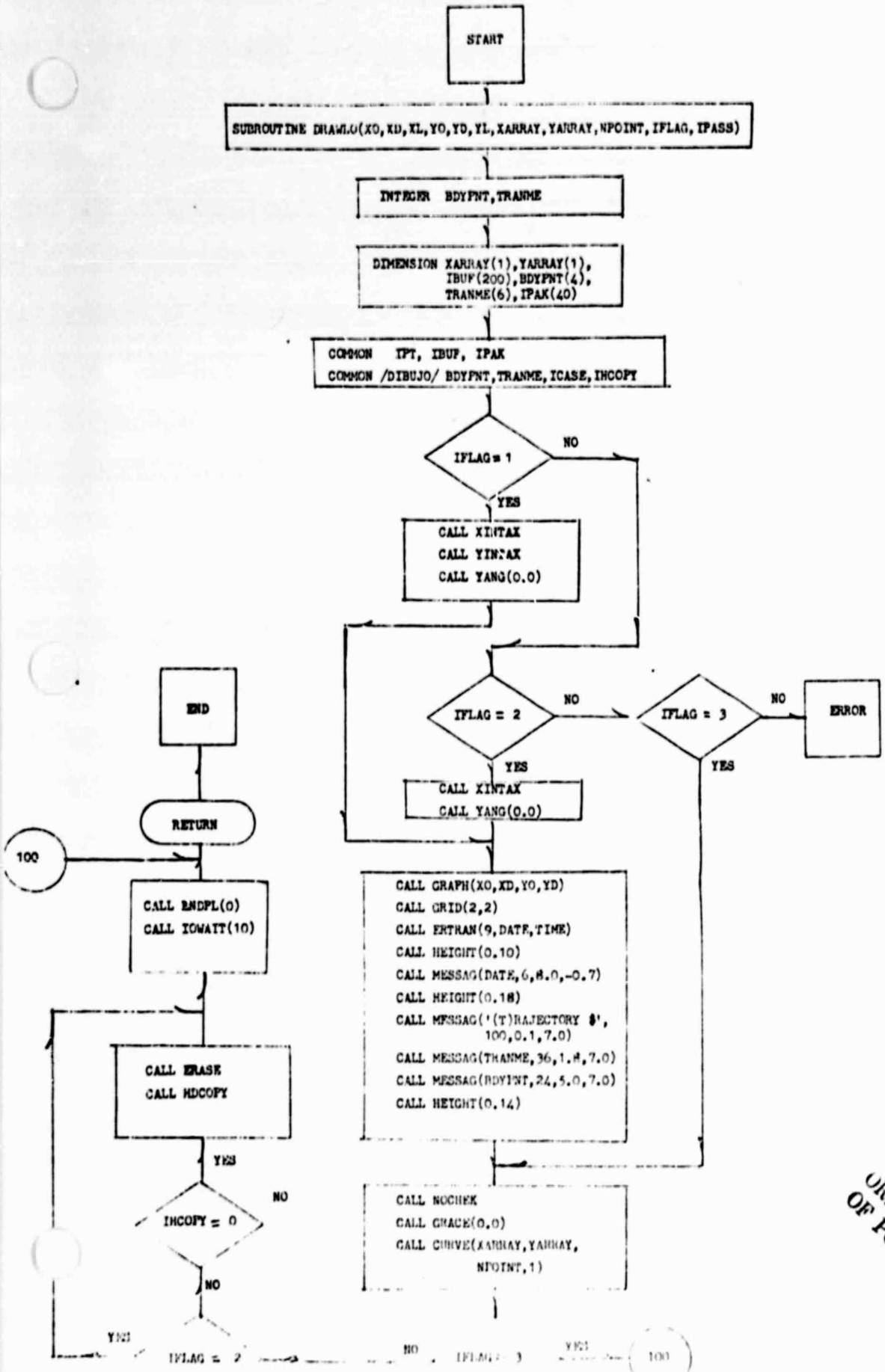
Libraries required : LOCALIB,DISSPLA,PLOT10

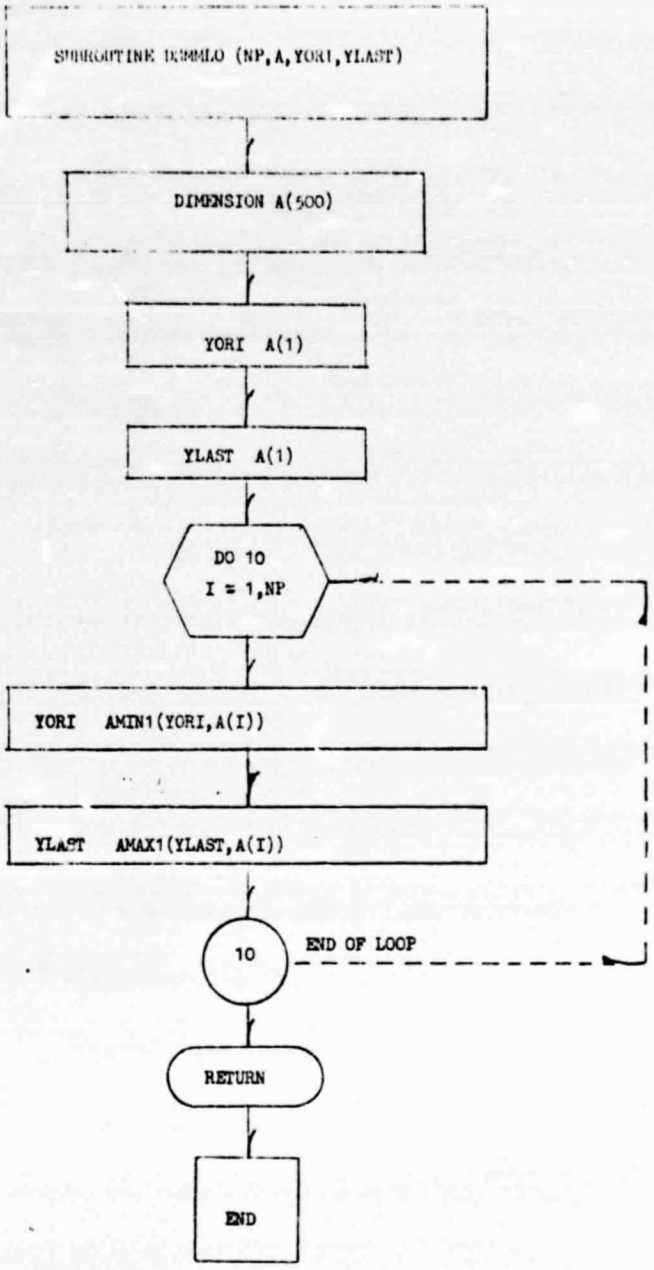
7.3 FLOWCHARTS

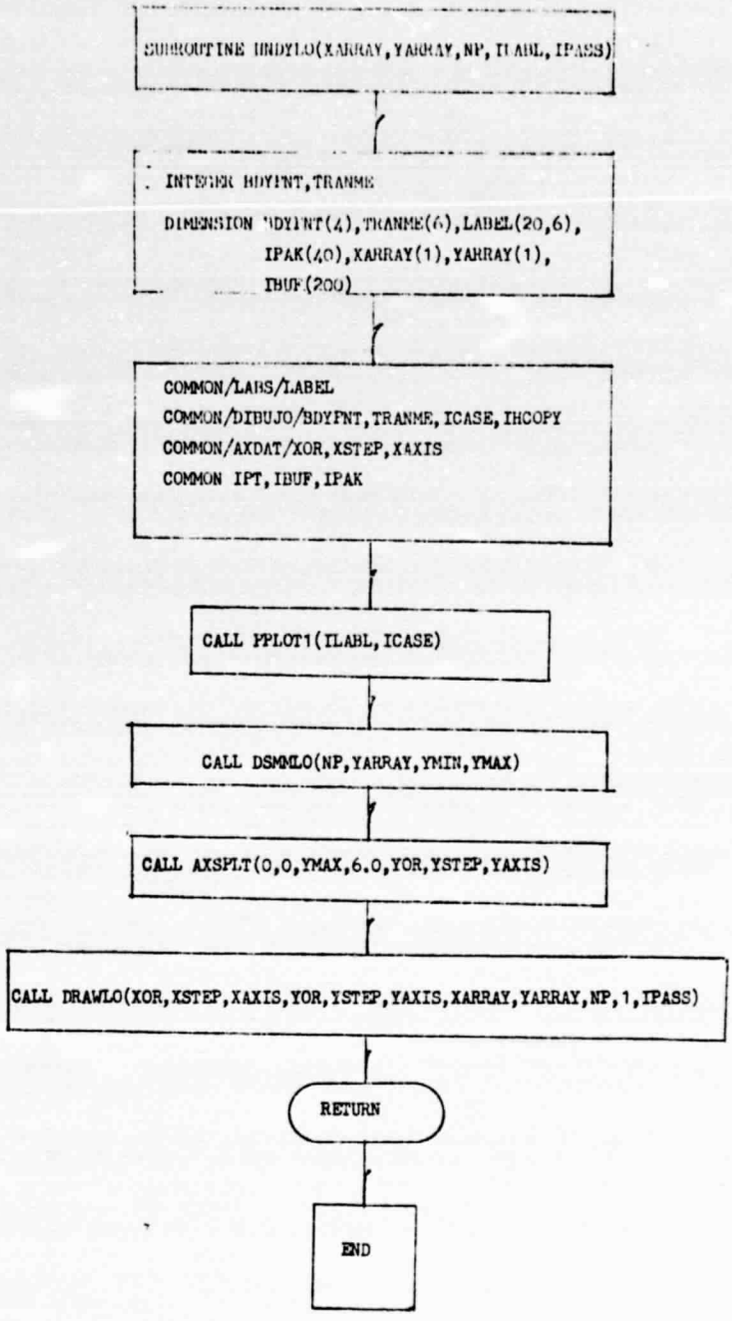


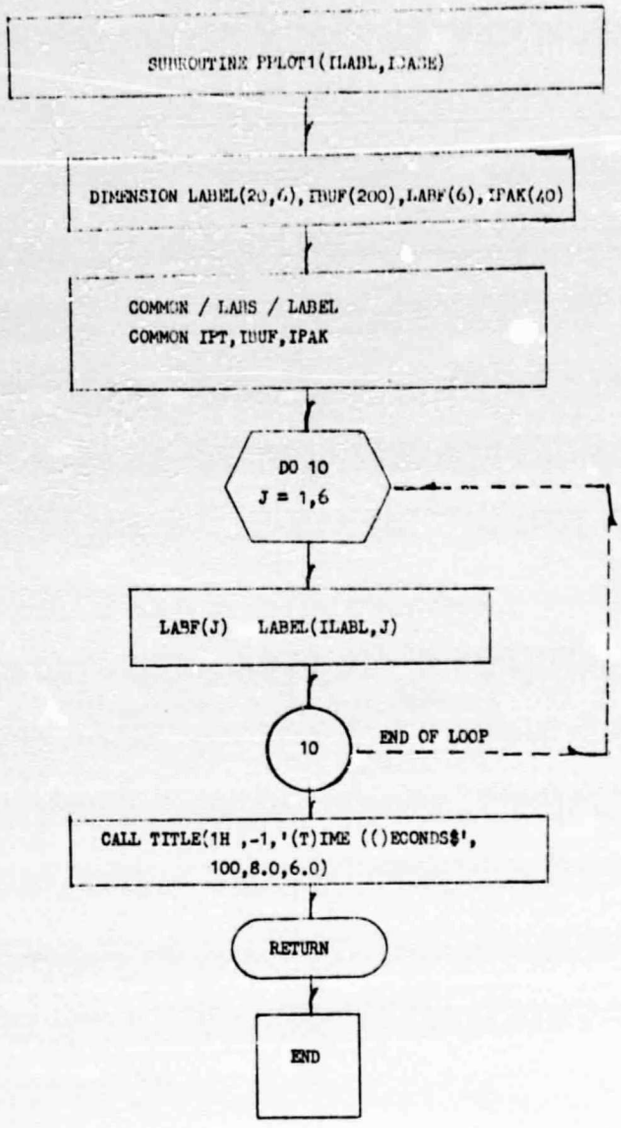
ORIGINAL PAGE IS OF POOR QUALITY


10
CALL D3M0LO(IT,QC1T,YMIN,YMAX)
CALL AXSPLT(0.0,YMAX,6.0,YOR,YSTEP,YAXIS)
CALL PPLOT1(11,ICASE)
CALL DRAWLO(XOR,XSTEP,XAXIS,YOR,YSTEP,YAXIS,
TIME1,QC1,IT,3,3)
CALL LINES('(T)W (R)AD (E)Q (T)EMP.$',IPAK,1)
CALL LINES('(T)W (D)EG. (F)$',IPAK,2)
IPT -1
CALL LEGEND(IPAK,2,2.5,6.2)
CALL INTNO(ITINIT,3.4,6.2)
IHCOPY= 0
YES
NO
CALL HDCOPY
CALL ERASE
CALL ENDPL(0)
20
LNGPLT = 0
YES
NO
CALL HNDYLO(TIME1,AKLZ1,IT,4,3)
ARIDEF 1
FALSE
30
TRUE
CALL HNDYLO(TIME1,AME1,IT,6,3)
NHFLAG = 1
YES
NO
27
CALL HNDYLO(TIME1,HFACZ1,IT,8,3)
28
CALL HNDYLO(TIME1,PE1,IT, 9,3)
CALL HNDYLO(TIME1,CP1,IT,10,3)
30
YES
ARIDEF ≠ 1
NO
CALL HNDYLO(TIME1,DELTAT,IT,11,3)
CALL HNDYLO(TIME1,TREF1,IT,12,3)
CALL HNDYLO(TIME1,TREF1,IT,12,3)
YES
ATRE > 0.001
NO
CALL HNDYLO(TIME1,TW1,IT,12,3)
ITHICK ≠ 0
FALSE
TRUE
CALL HNDYLO(TIME1,TW2,IT,12,3)
RETURN
END



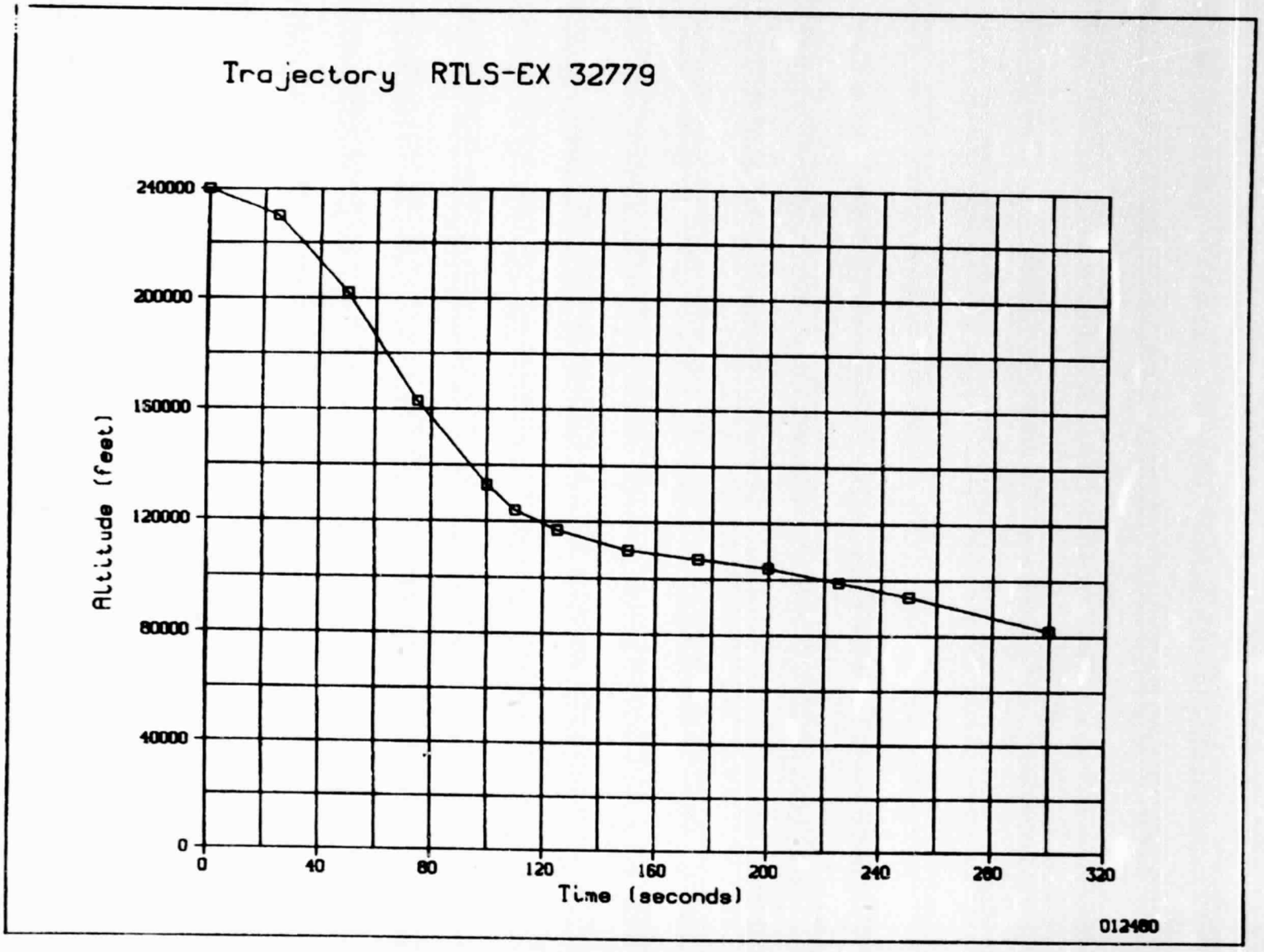

SUBROUTINE DEMMLO (NP,A,YORI,YLAST)
DIMENSION A(500)
YORI A(1)
YLAST A(1)
DO 10
I = 1,NP
YORI AMIN1(YORI,A(I))
YLAST AMAX1(YLAST,A(I))
10
END OF LOOP
RETURN
END

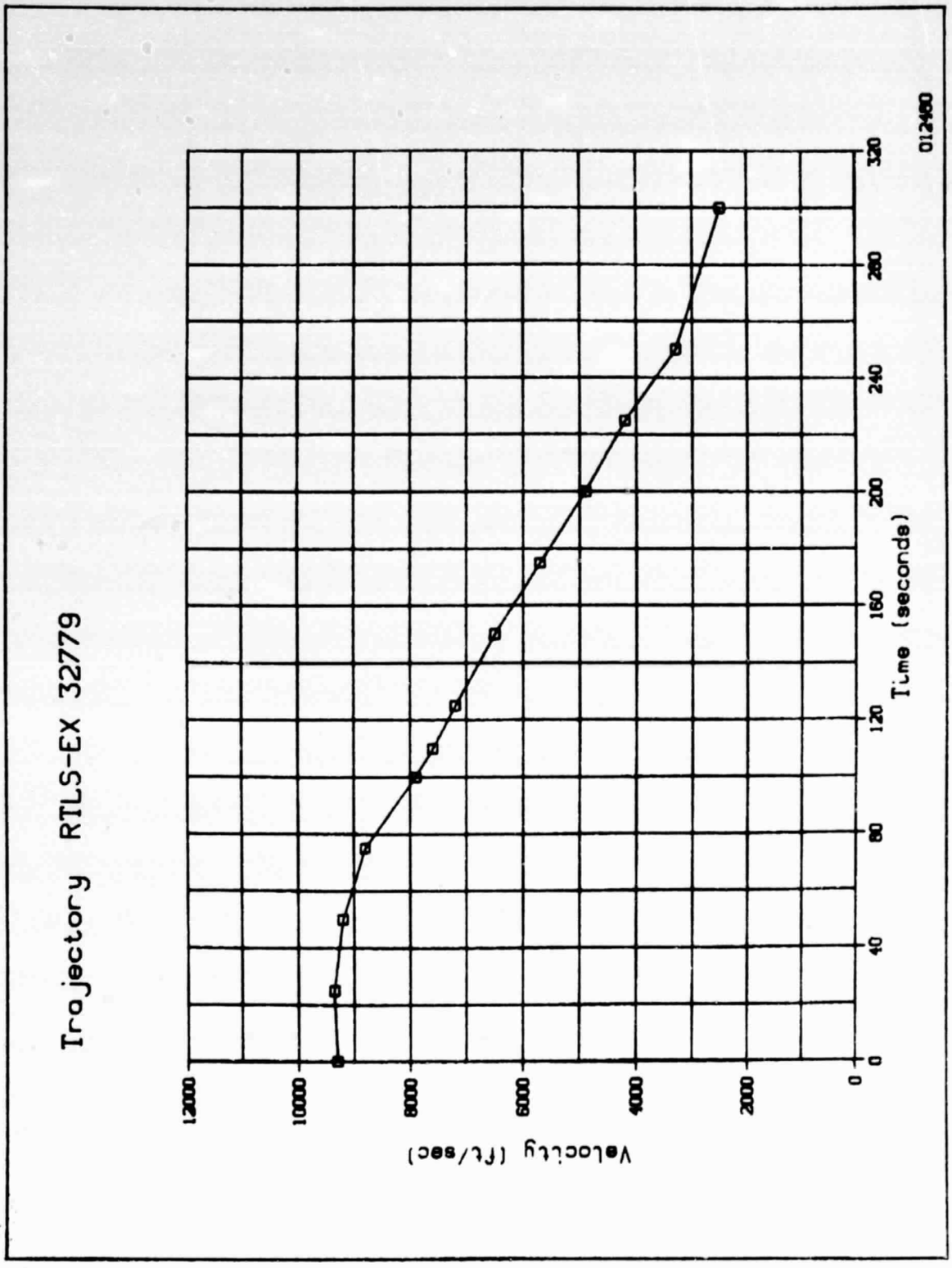


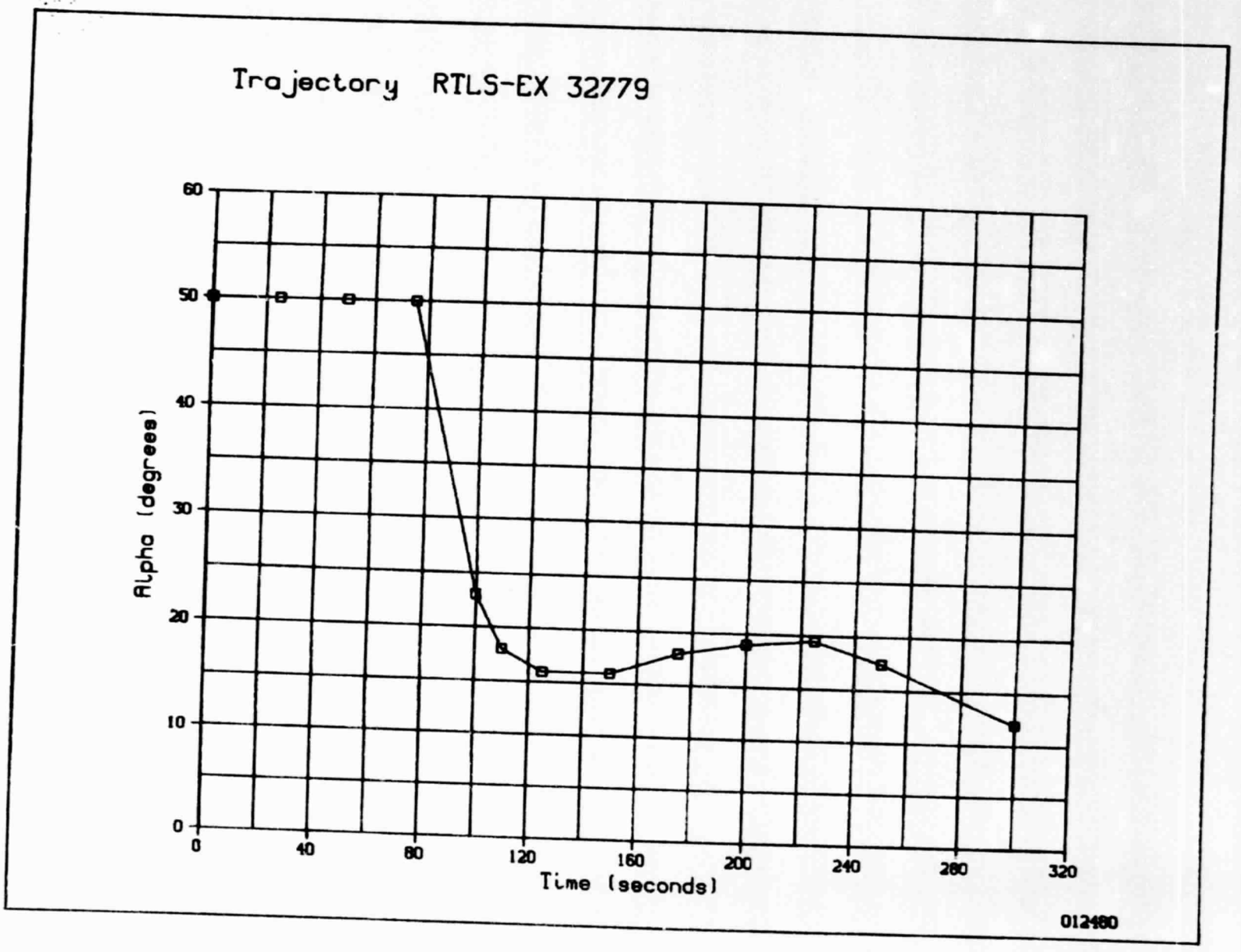

SUBROUTINE PPLOT1(ILABL,LBASE)
DIMENSION LABEL(20,6),IBUF(200),LABF(6),IPAK(40)
COMMON / LABS / LABEL
COMMON IPT,IBUF,IPAK
DO 10
J = 1,6
LABF(J) LABEL(ILABL,J)
10
END OF LOOP
CALL TITLE(1H ,-1,'(T)IME (()ECONDS$',
100,8.0,6.0)
RETURN
END

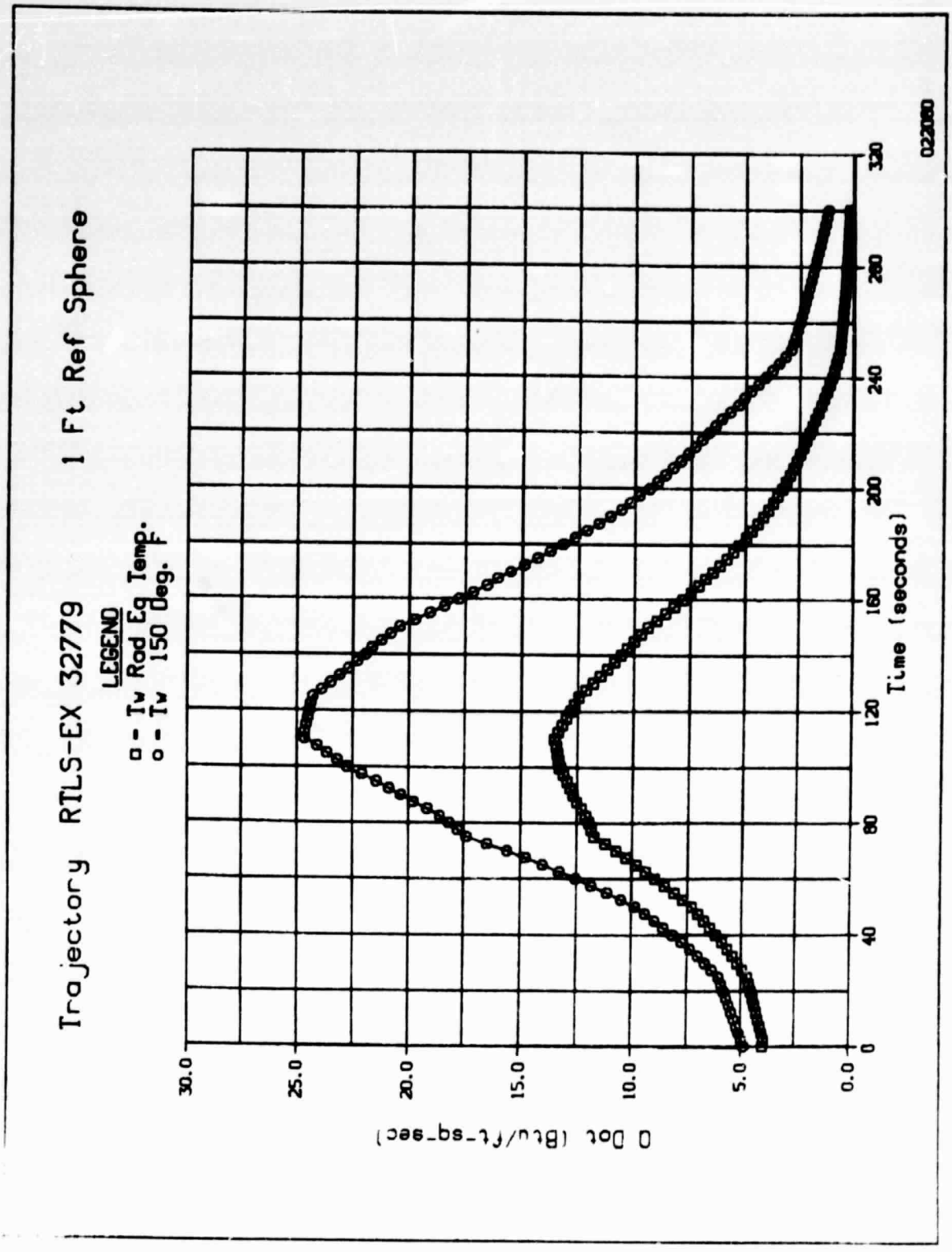
7.4 PLOTS OUTPUT

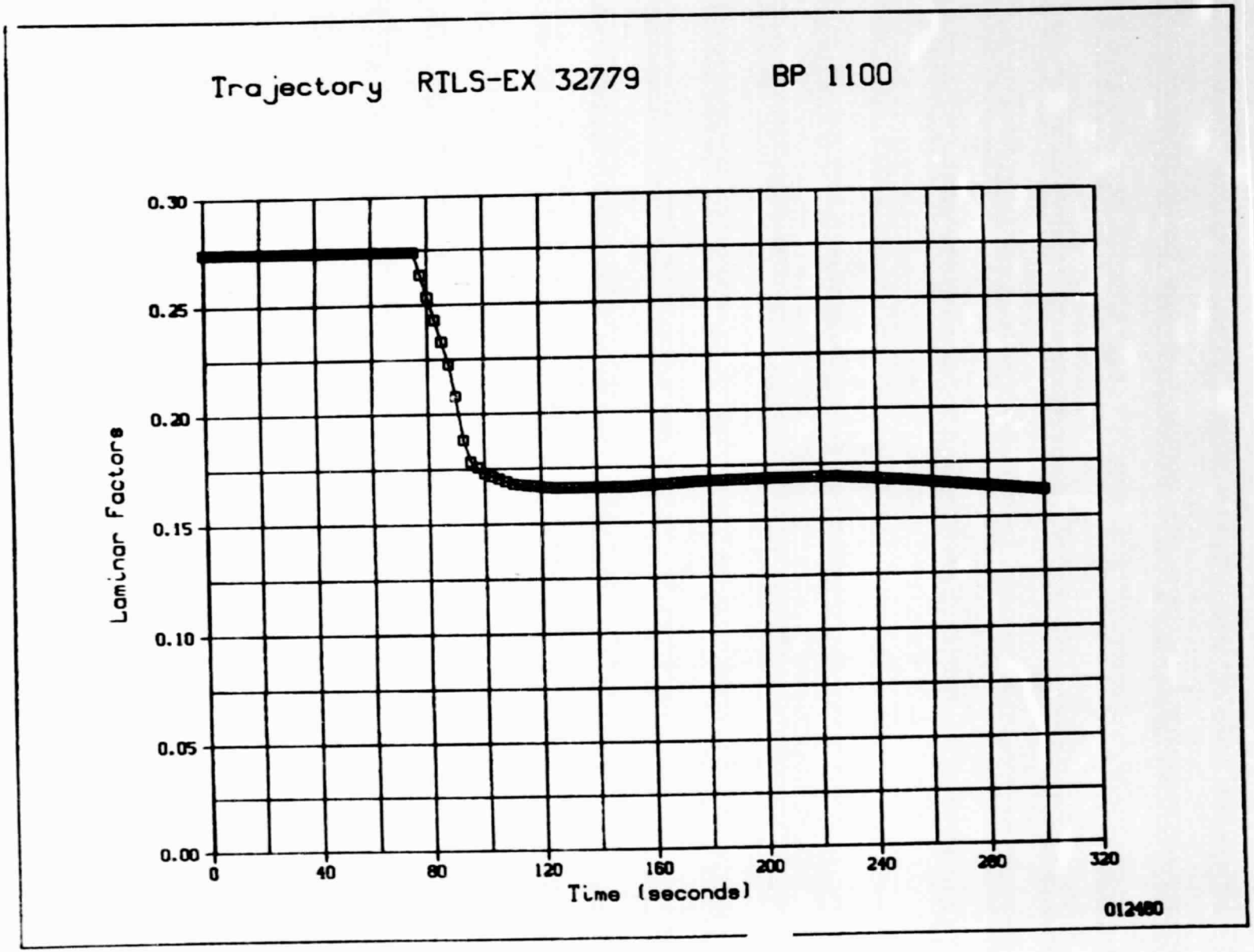
The plots correspond to the input listing in section 5.

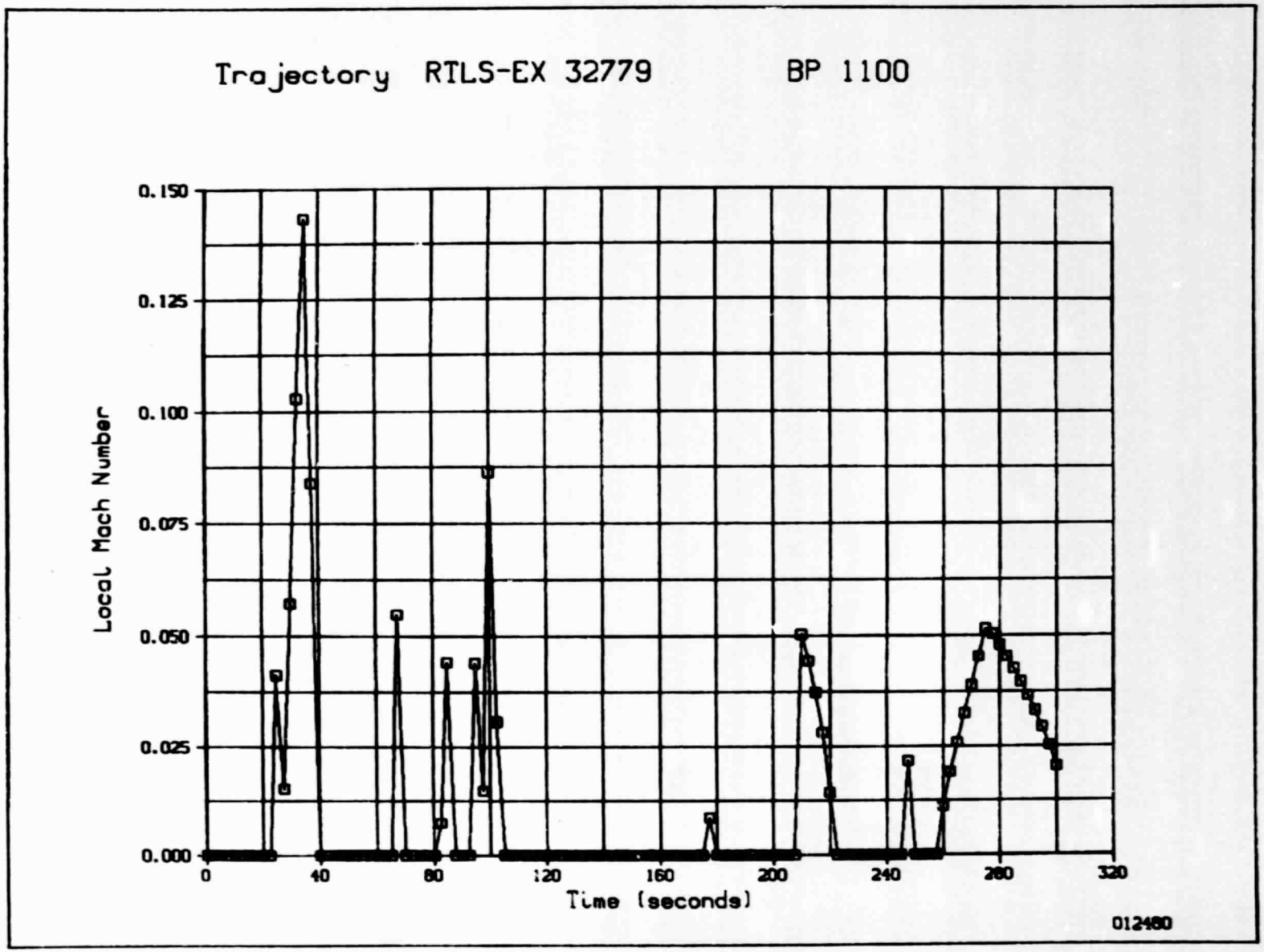

Trajectory RTLS-EX 32779
240000
200000
150000
120000
80000
40000
0
Altitude (feet)
0
40
80
120
160
200
240
280
320
Time (seconds)
012480

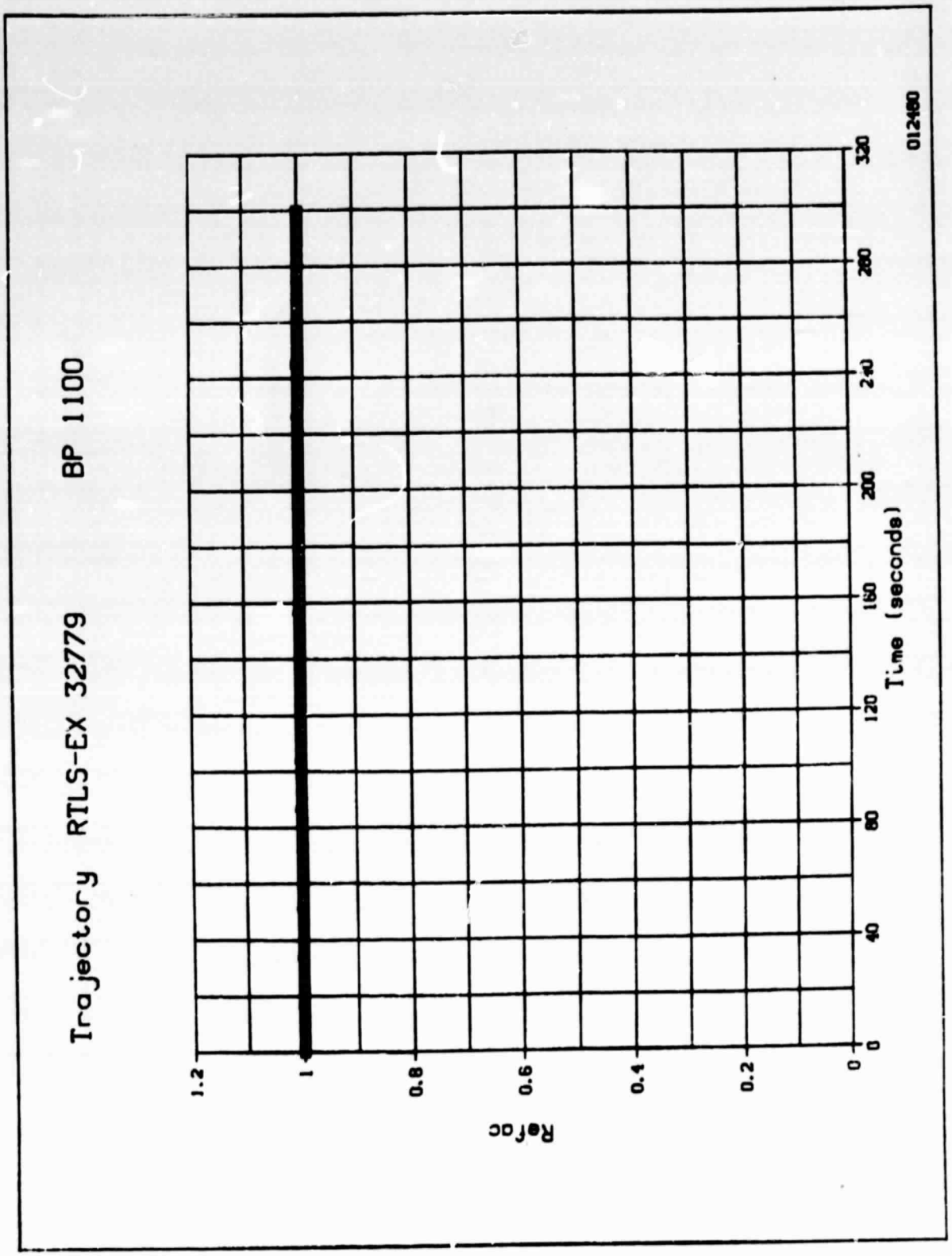

Trajectory RTLS-EX 32779
012480
Velocity (ft/sec)
12000
10000
8000
6000
4000
2000
0
0
40
80
120
160
200
240
280
320
Time (seconds)

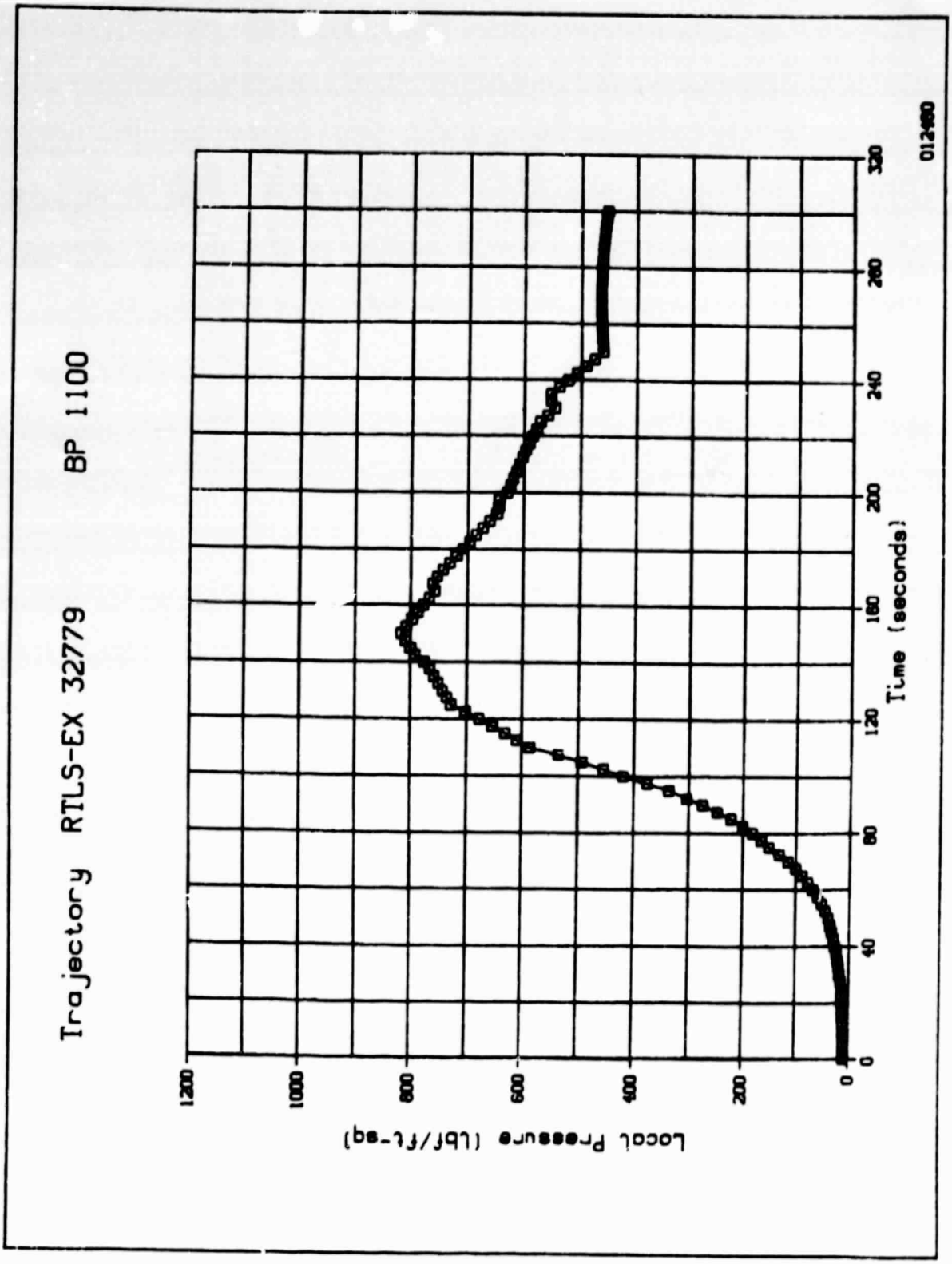

Trajectory RTLS-EX 32779
Alpha (degrees)
60
50
40
30
20
10
0
0
40
80
120
160
200
240
280
320
Time (seconds)
012480

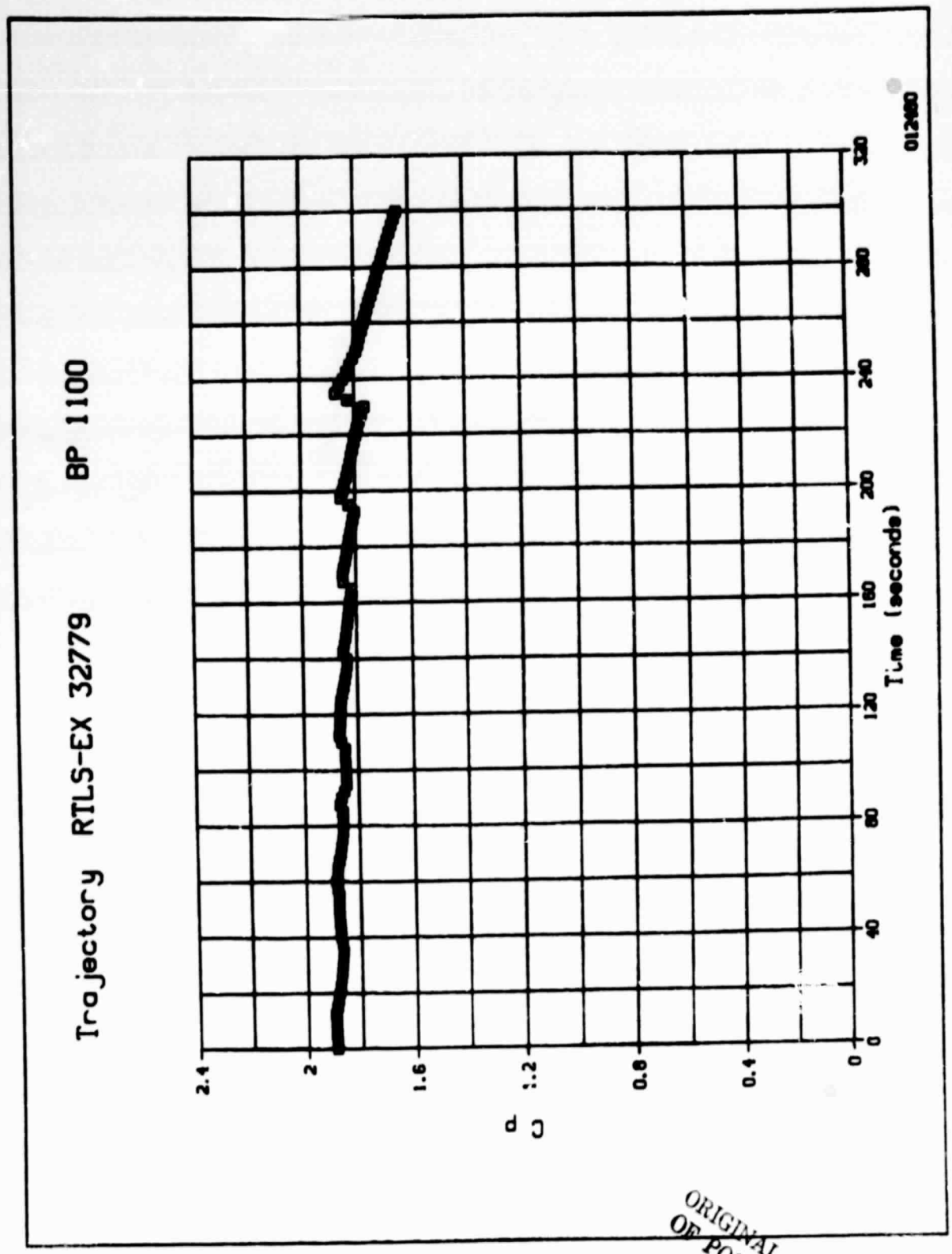


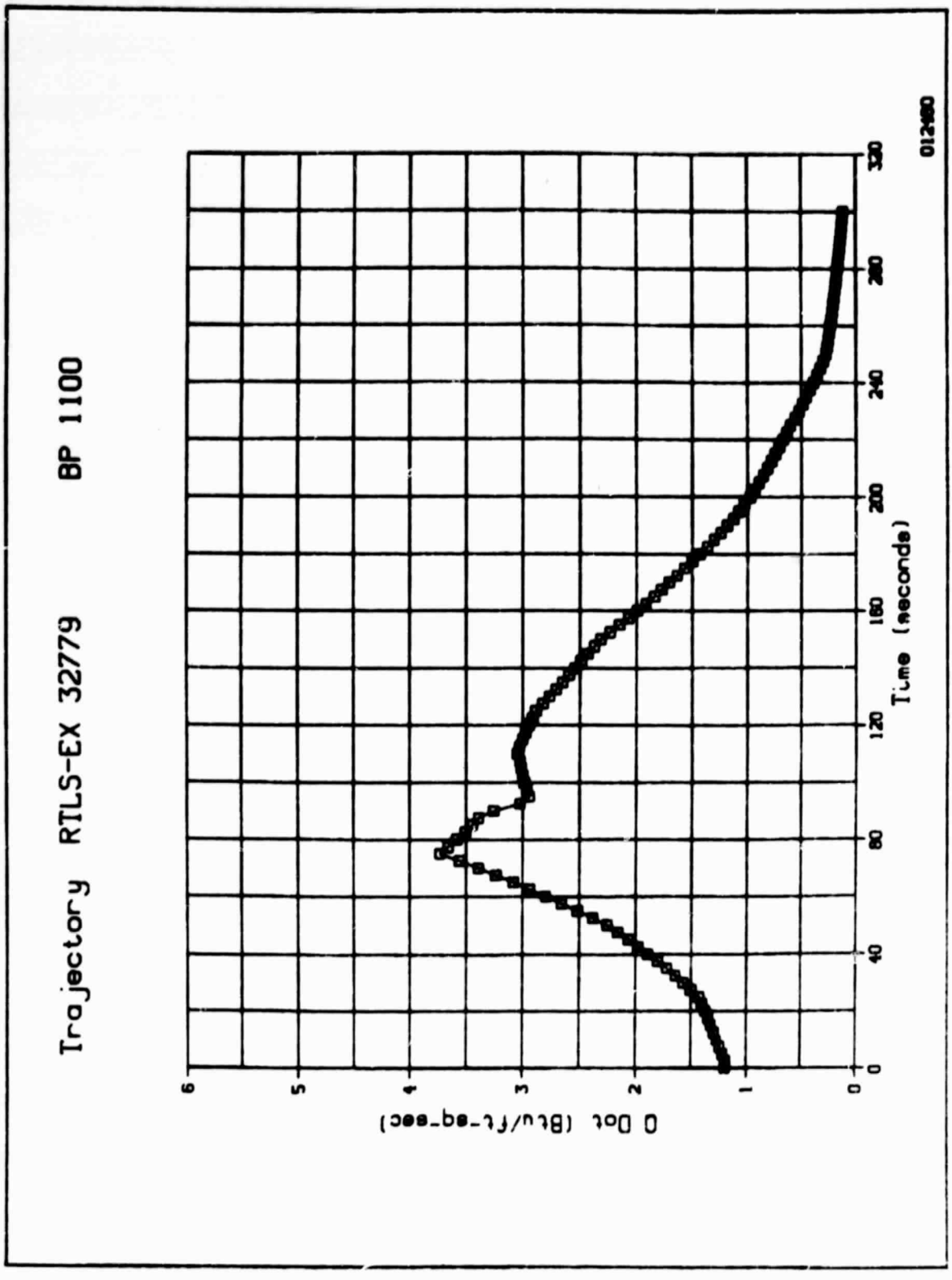

Trajectory RTLS-EX 32779 BP 1100
Laminar Factors
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
40
80
120
160
200
240
280
320
Time (seconds)
012480

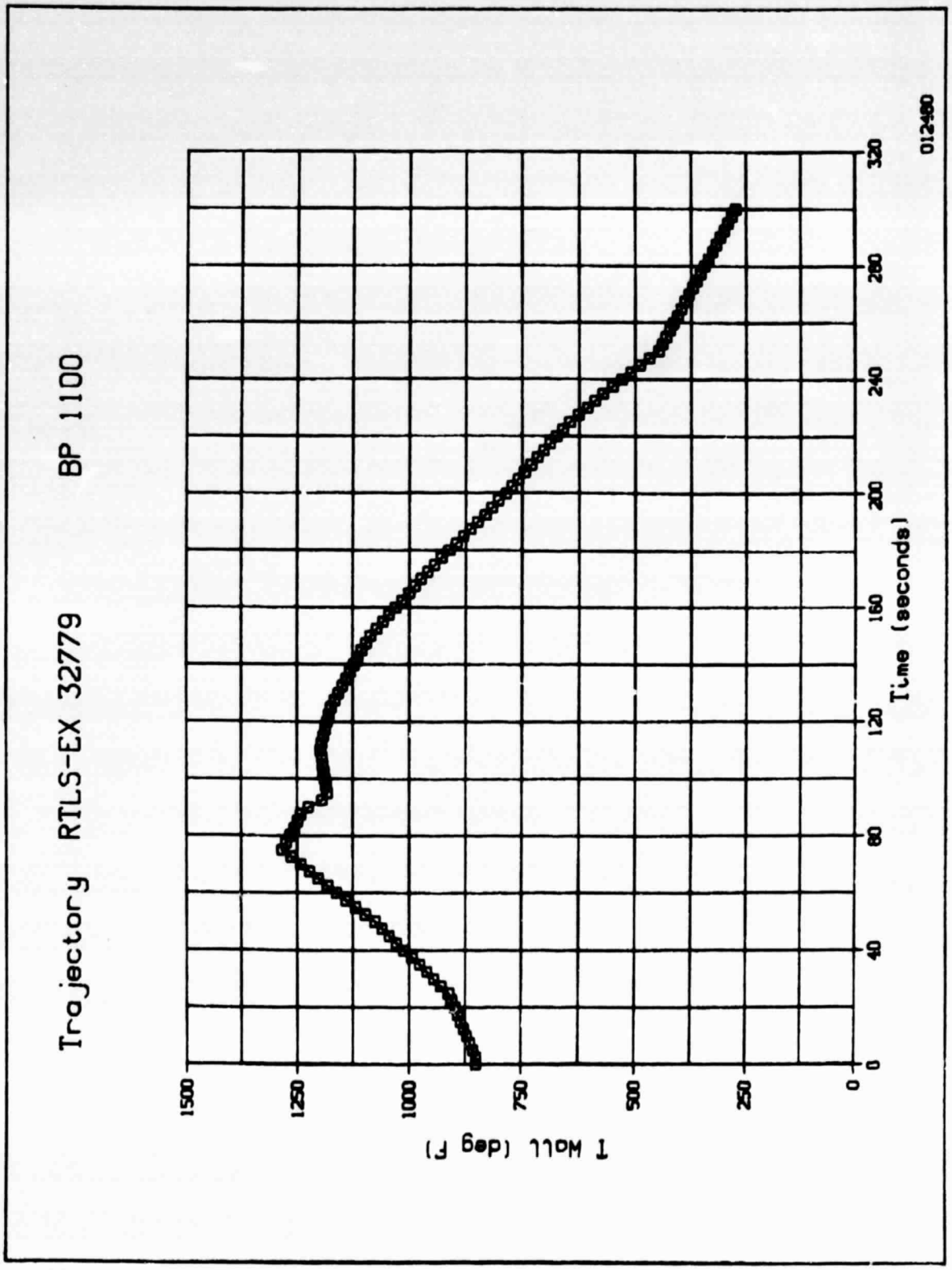

Trajectory RTLS-EX 32779 BP 1100
Local Mach Number
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0
40
80
120
160
200
240
280
320
Time (seconds)
012480


Trajectory RTLS-EX 32779 BP 1100
012480
Time (seconds)
0
40
80
120
160
200
240
280
320
Refpc
0
0.2
0.4
0.6
0.8
1
1.2

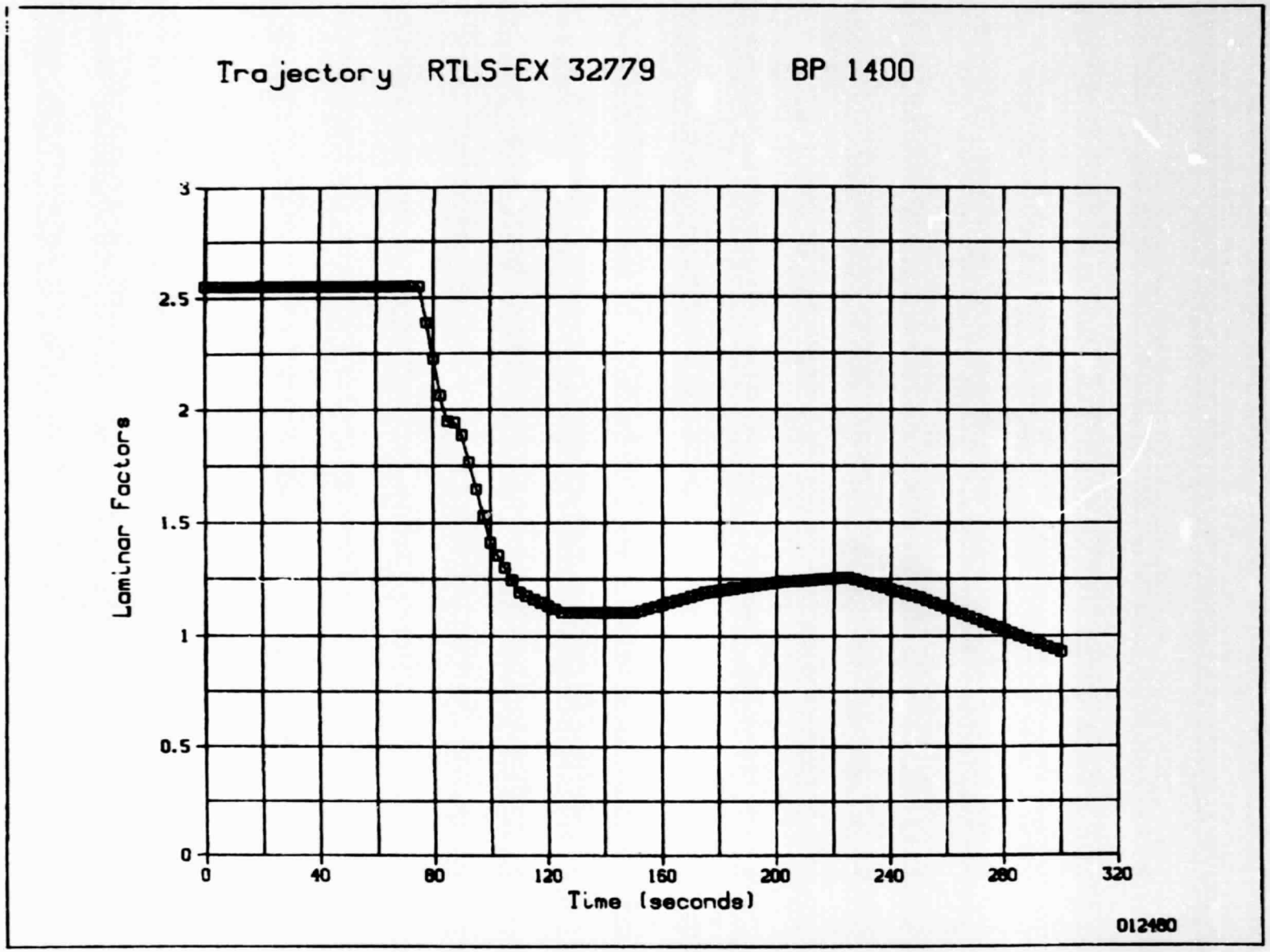

Trajectory RTLS-EX 32779 BP 1100
Local Pressure (lbf/ft-sq)
1200
1000
800
600
400
200
0
0
40
80
120
160
200
240
280
320
Time (seconds)
012480

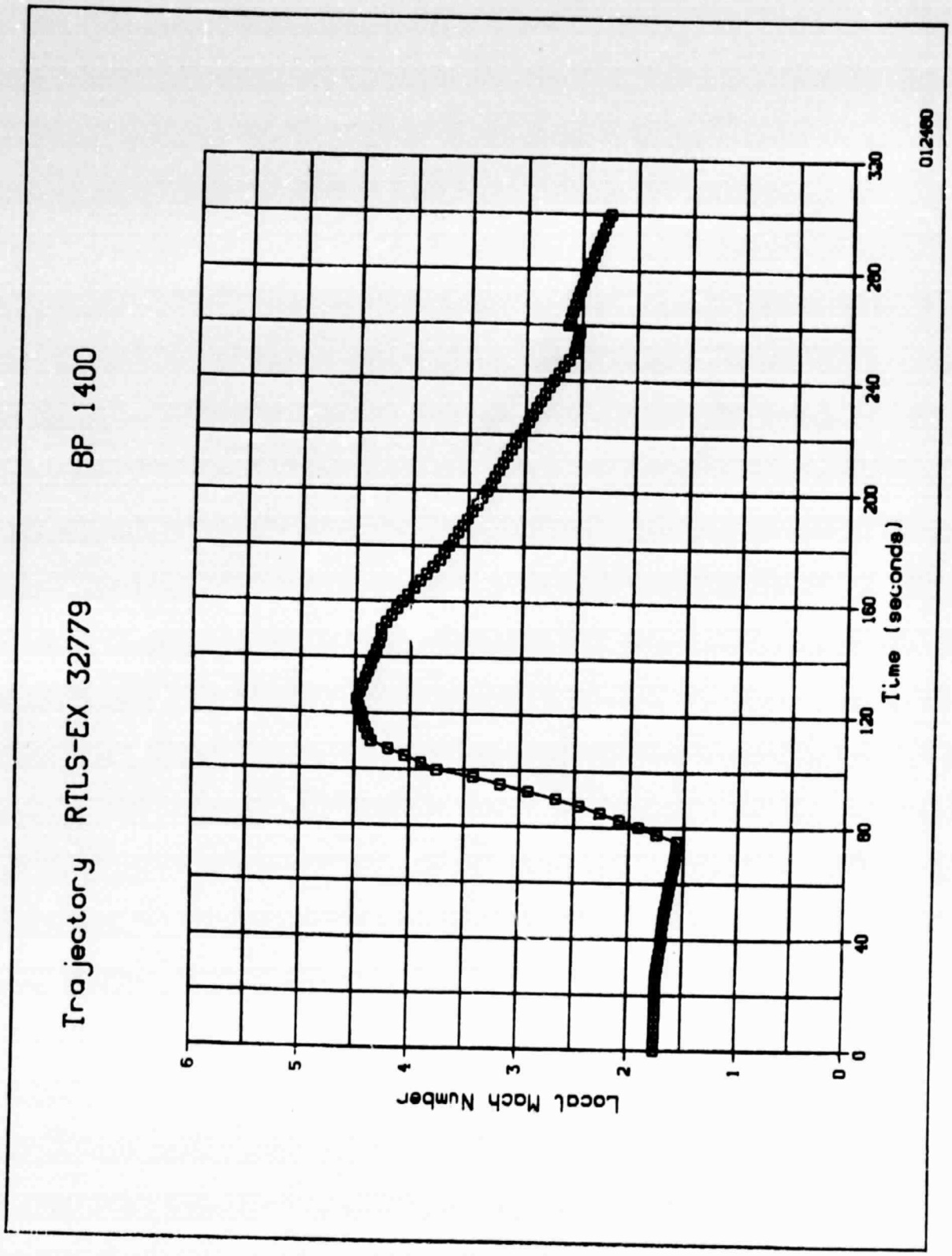


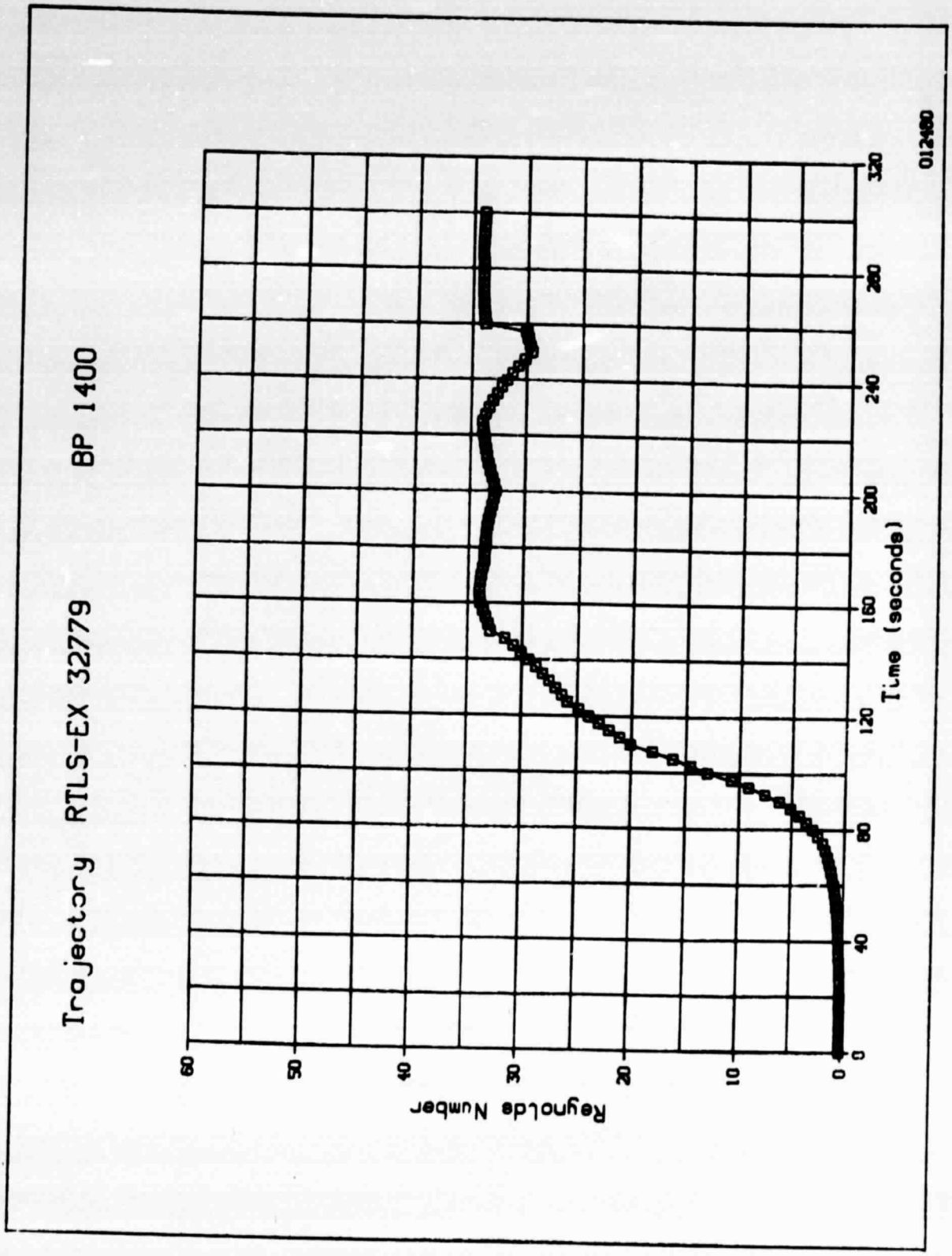

Trajectory RTLS-EX 32779 BP 1100
012490
Q Dot (Btu/ft-sq-sec)
Time (seconds)
0
1
2
3
4
5
6
0
40
80
120
160
200
240
280
320

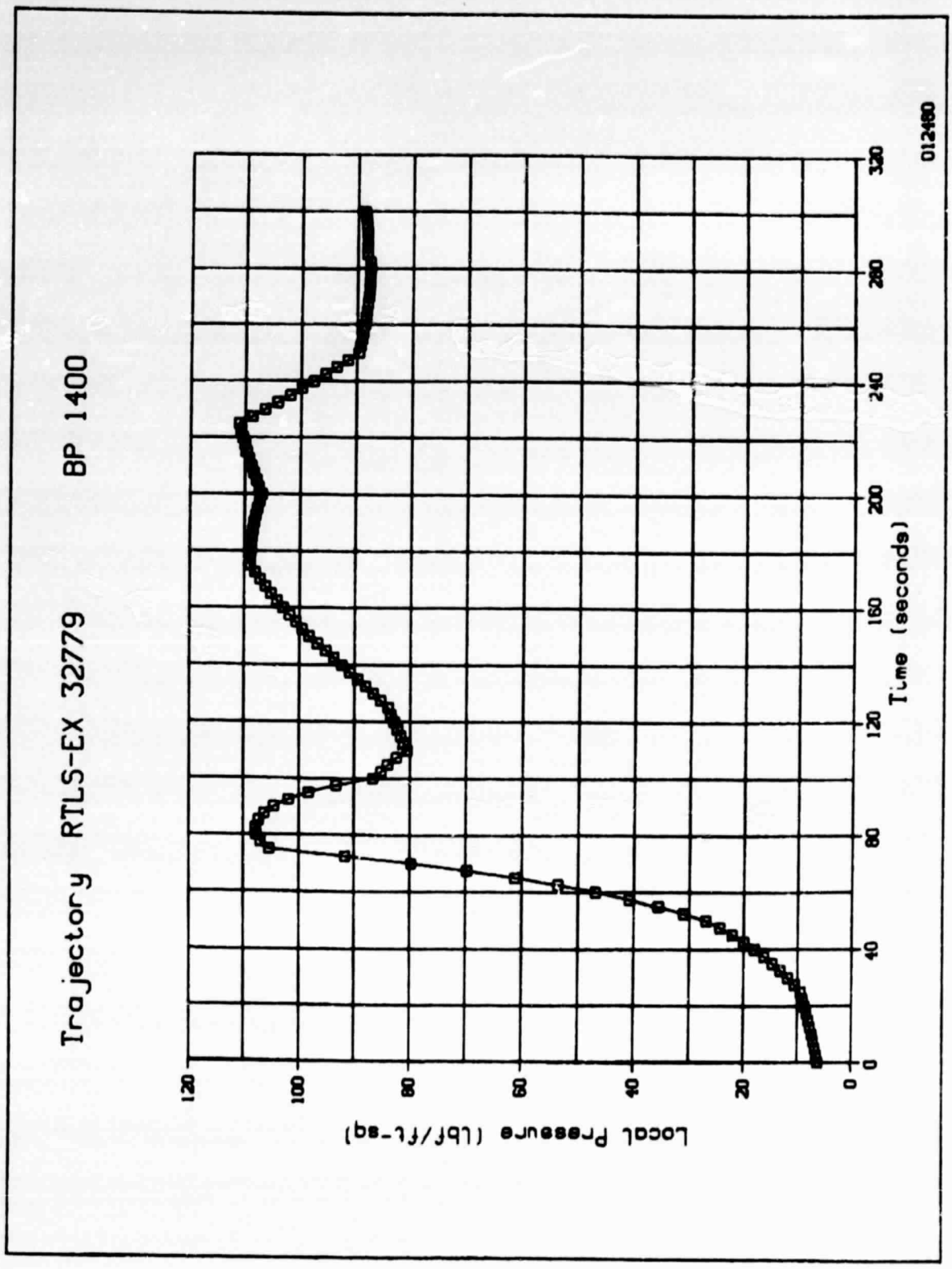

Trajectory RTLS-EX 32779 BP 1100
T Roll (deg F)
Time (seconds)
012480
1500
1250
1000
750
500
250
0
0
40
80
120
160
200
240
280
320

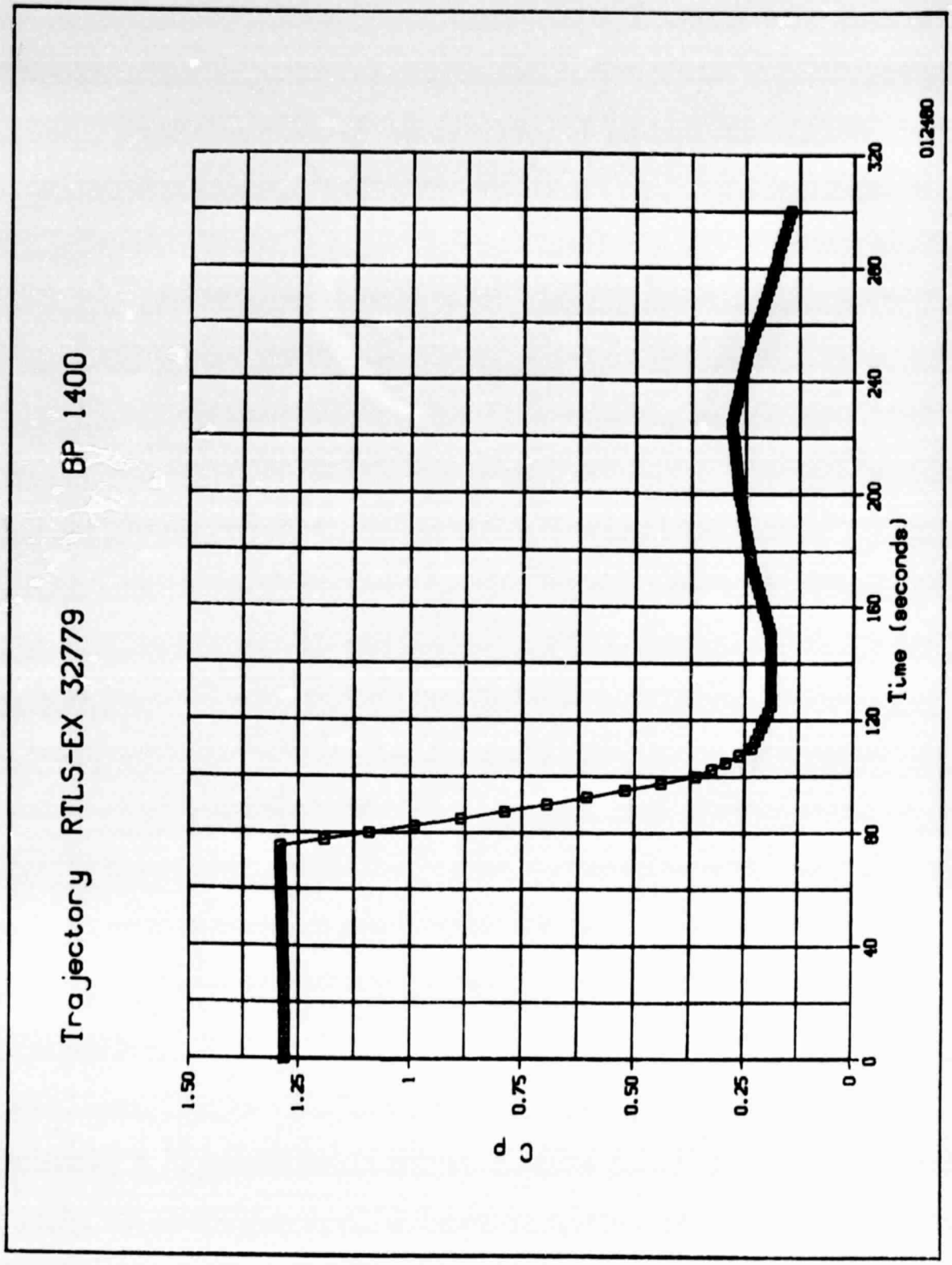
C-7


Trajectory RTLS-EX 32779 BP 1400
Laminar Factors
3
2.5
2
1.5
1
0.5
0
0
40
80
120
160
200
240
280
320
Time (seconds)
012480


Trajectory RTLS-EX 32779 BP 1400
Local Mach Number
Time (seconds)
0
1
2
3
4
5
6
0
40
80
120
160
200
240
280
320
012480


Trajectory RTLS-EX 32779 BP 1400
012480
Reynolds Number
Time (seconds)
0
10
20
30
40
50
60
0
40
80
120
160
200
240
280
320


Trajectory RTLS-EX 32779 BP 1400
Local Pressure (lbf/ft-sq)
Time (seconds)
0
20
40
60
80
100
120
0
40
80
120
160
200
240
280
320
012480



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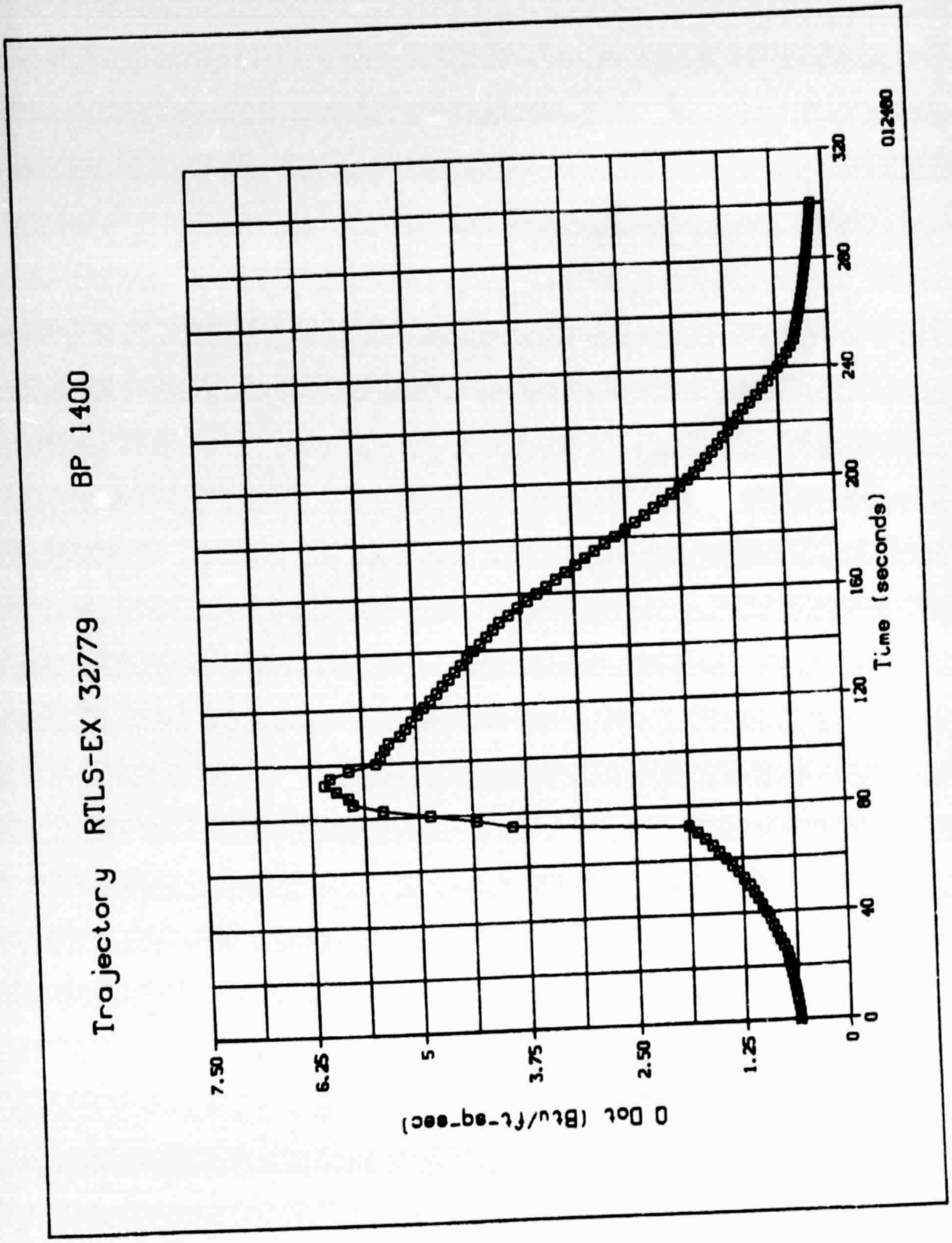
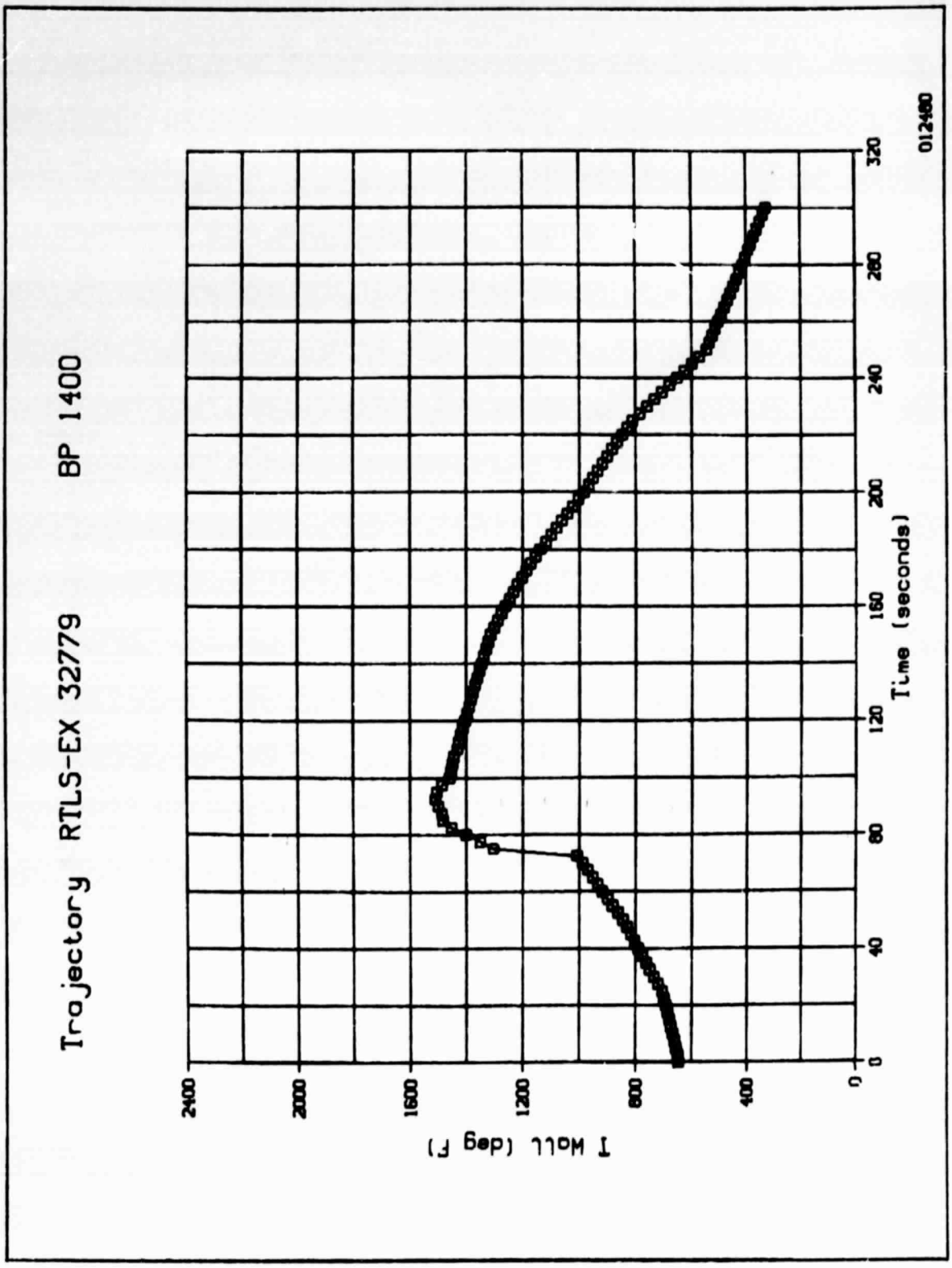
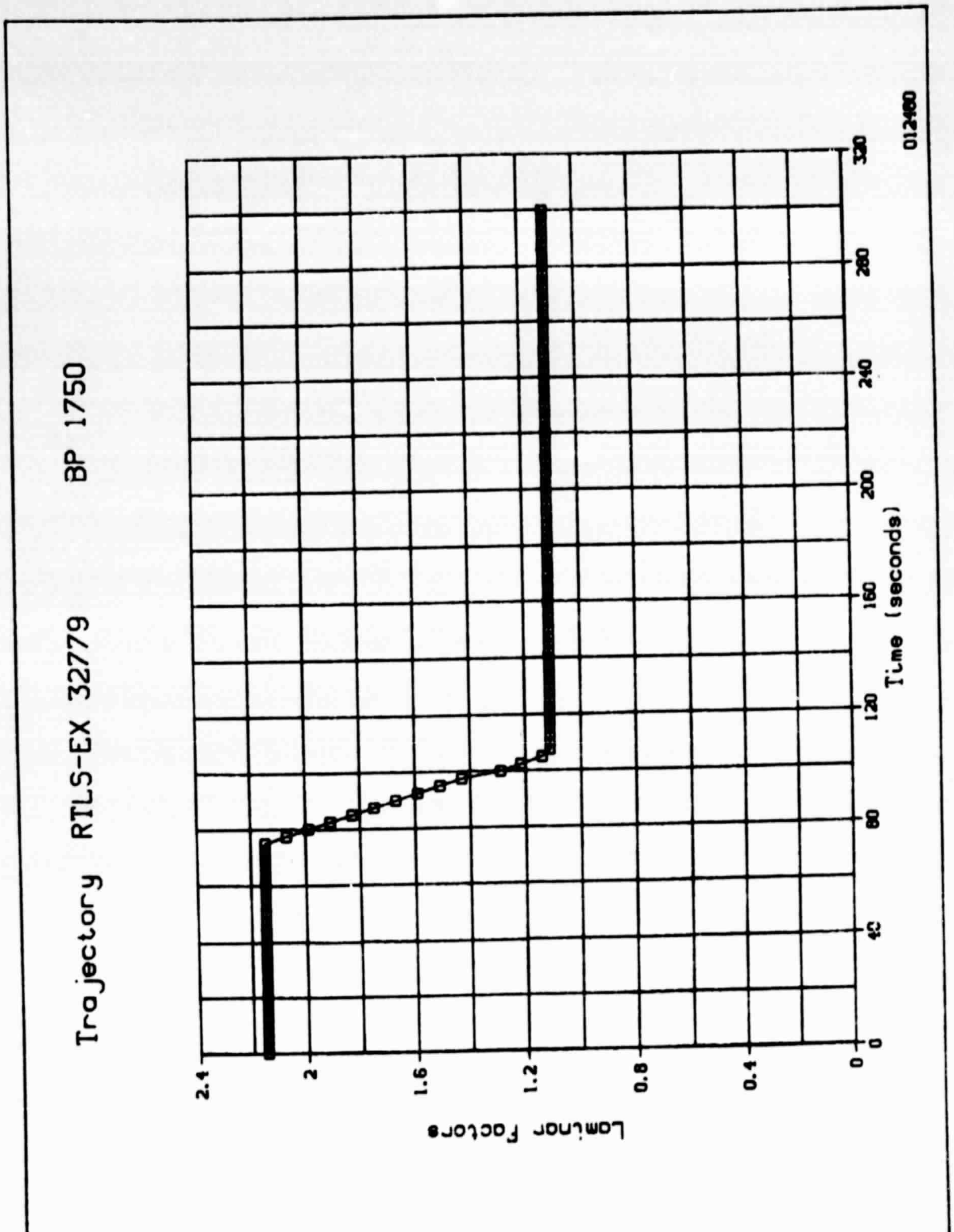
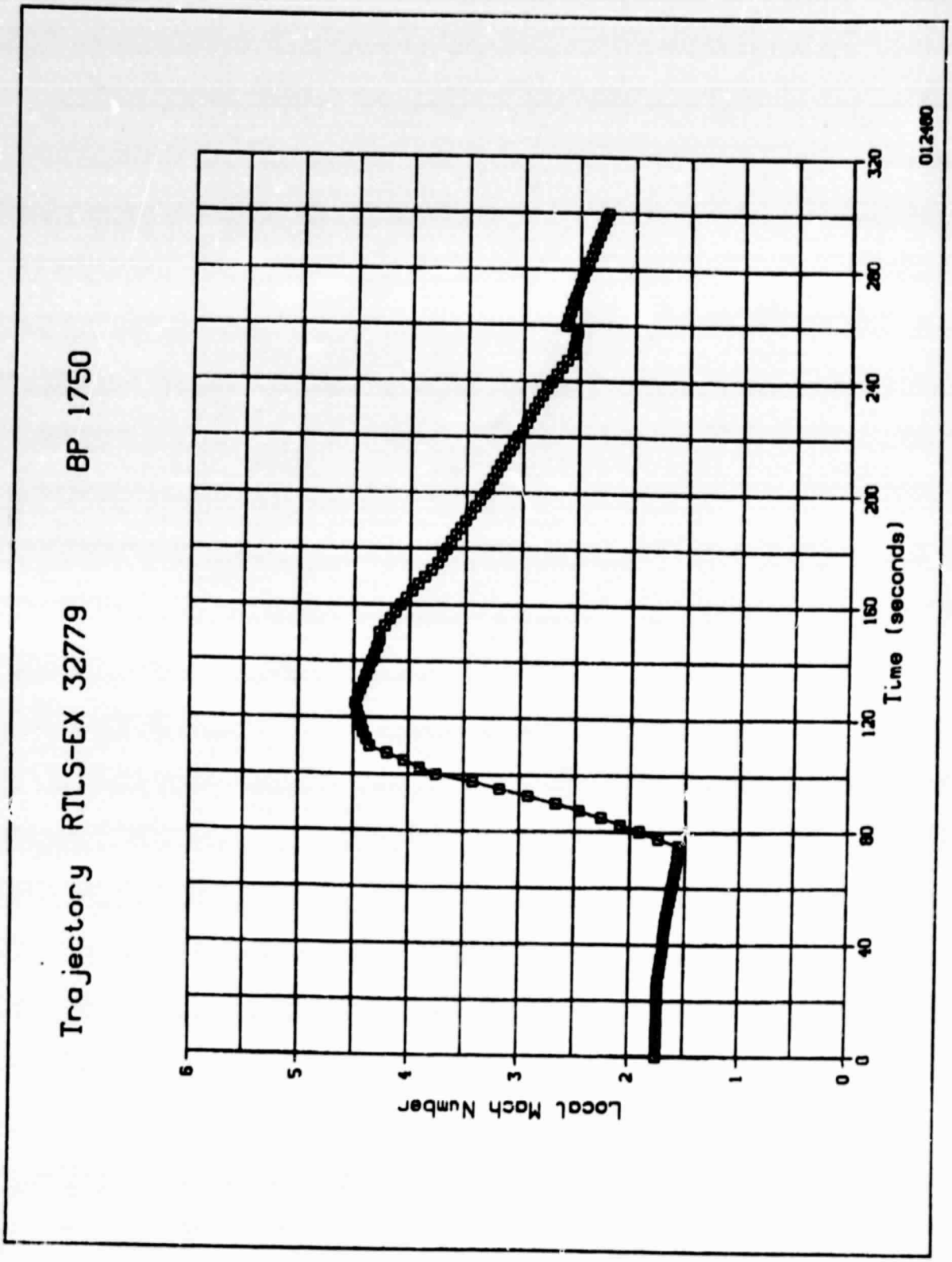
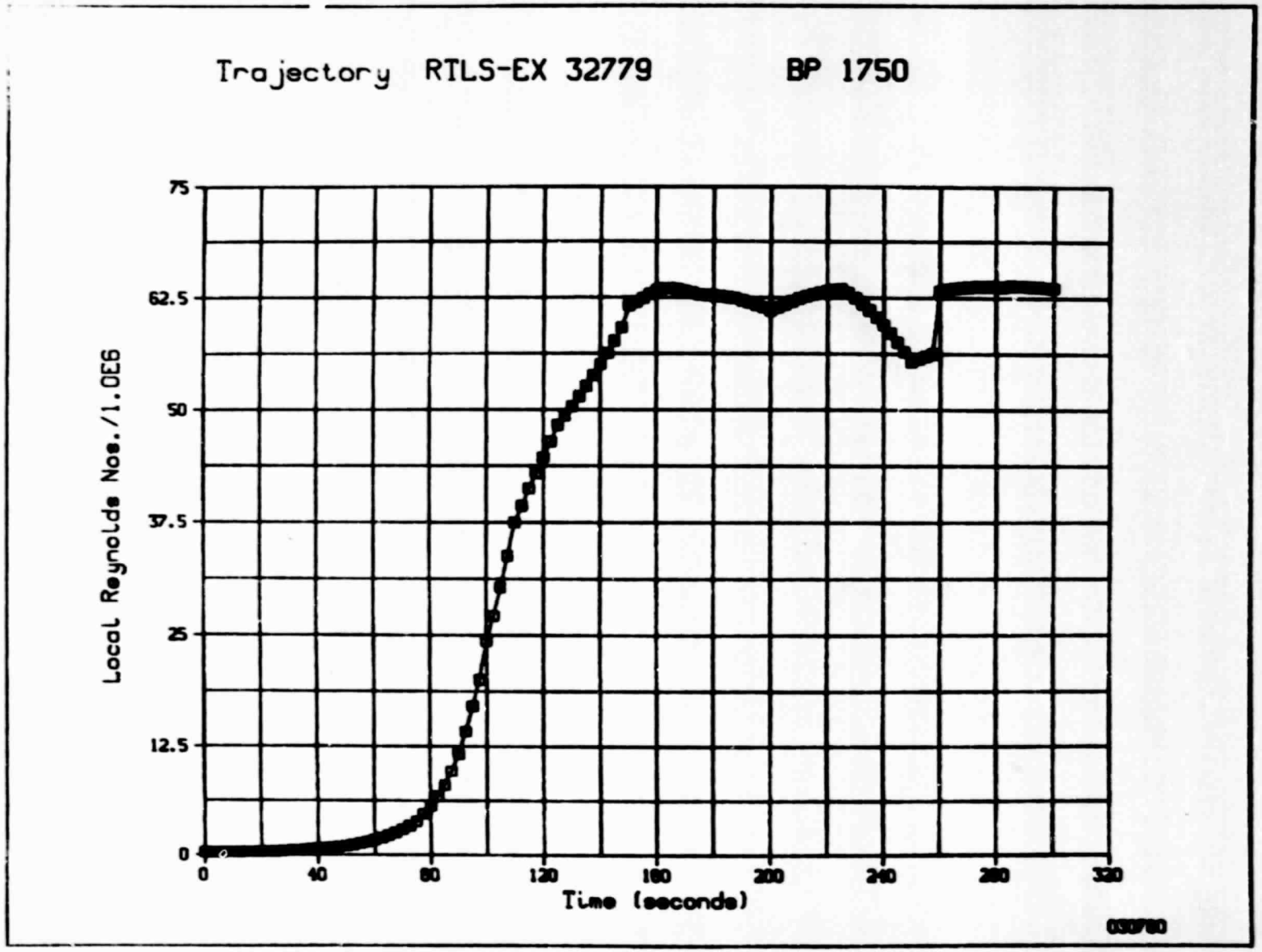

Trajectory RTLS-EX 32779 BP 1400
Q Dot (Btu/ft-sq-sec)
Time (seconds)
0
1.25
2.50
3.75
5
6.25
7.50
0
40
80
120
160
200
240
280
320
012460

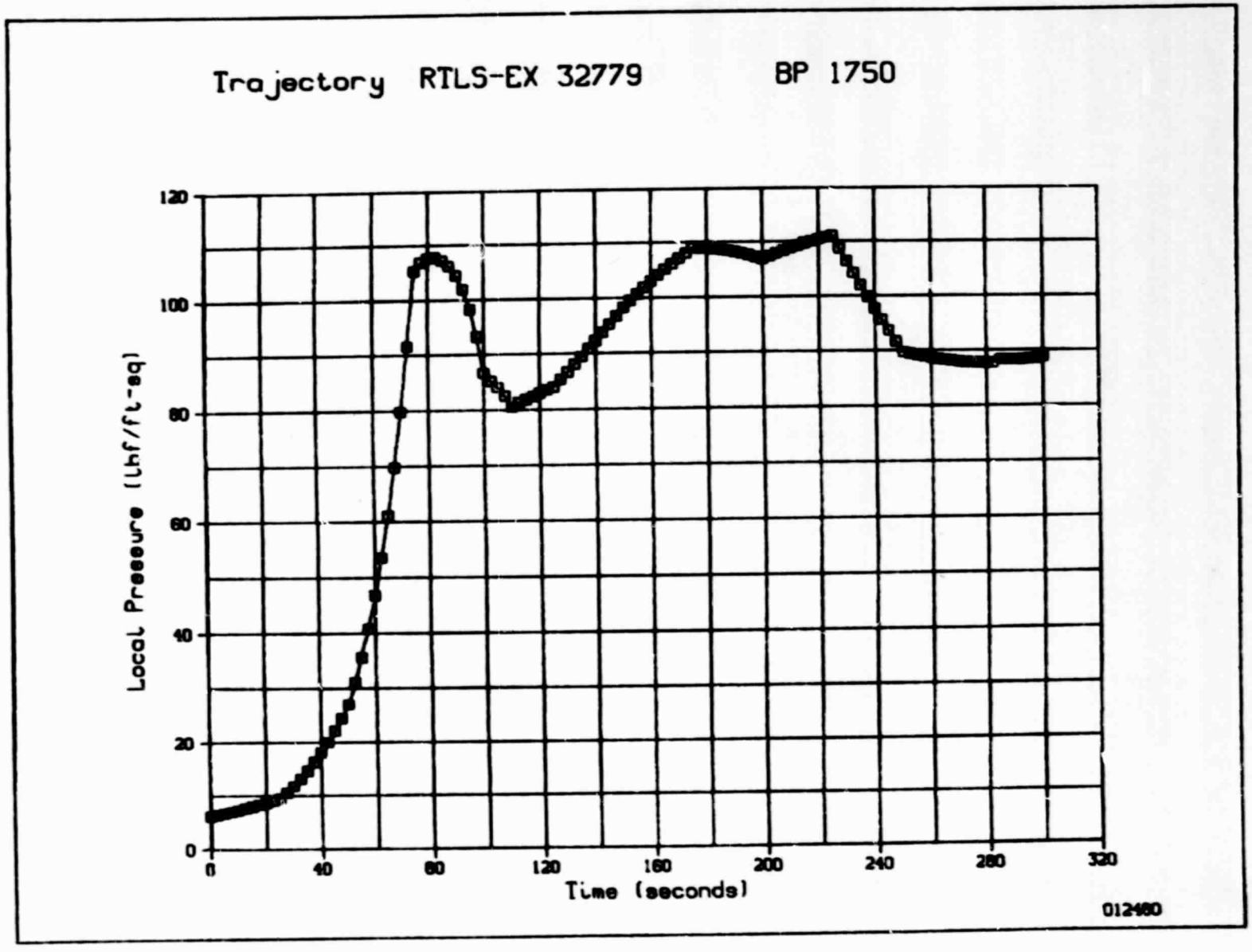

Trajectory RTLS-EX 32779 BP 1400
012480
T Wall (deg F)
2400
2000
1600
1200
800
400
0
0
40
80
120
160
200
240
280
320
Time (seconds)

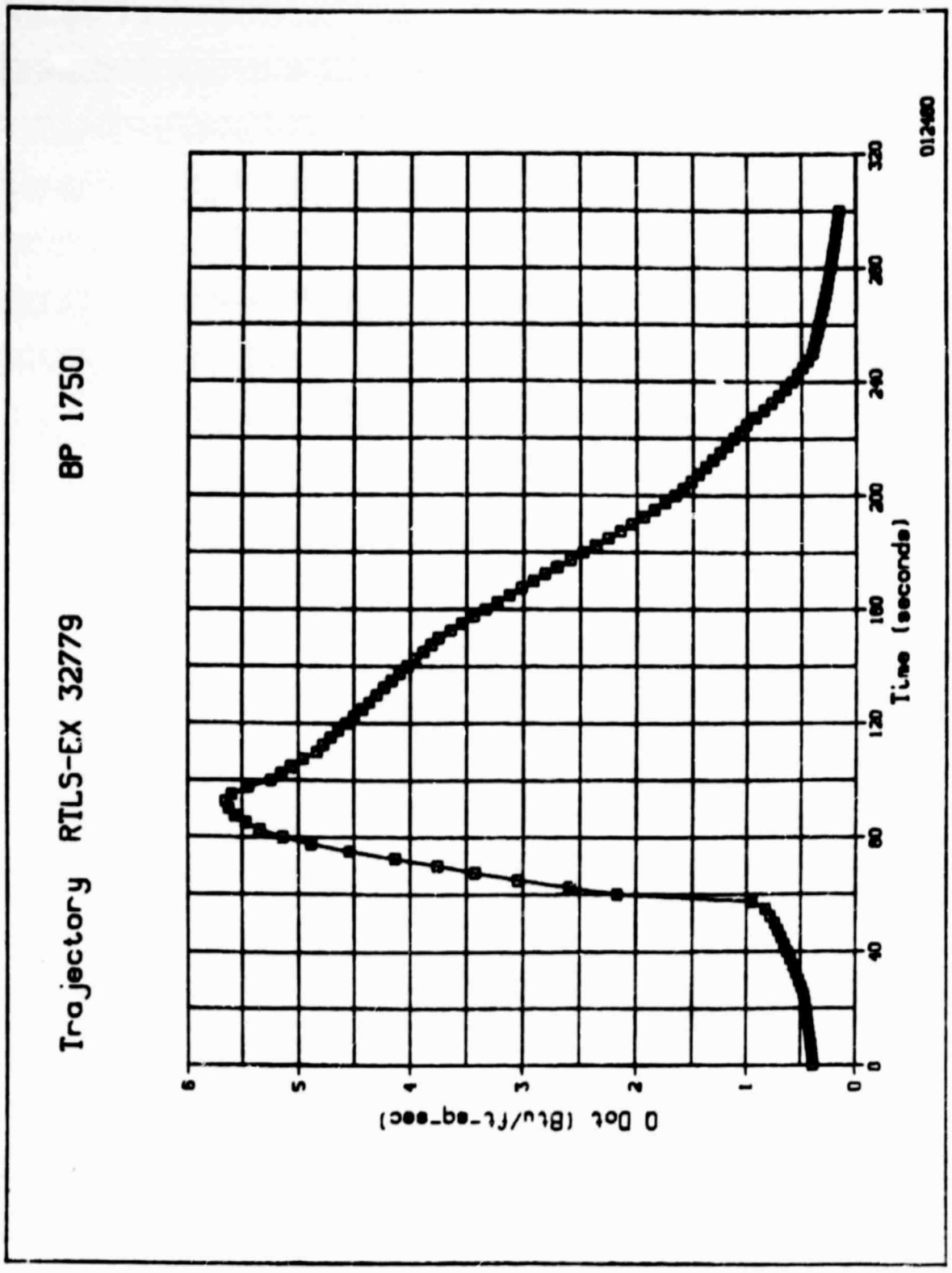

Trajectory RTLS-EX 32779 BP 1750
Laminar Factors
Time (seconds)
0
0.4
0.8
1.2
1.6
2
2.4
0
40
80
120
160
200
240
280
320
012480

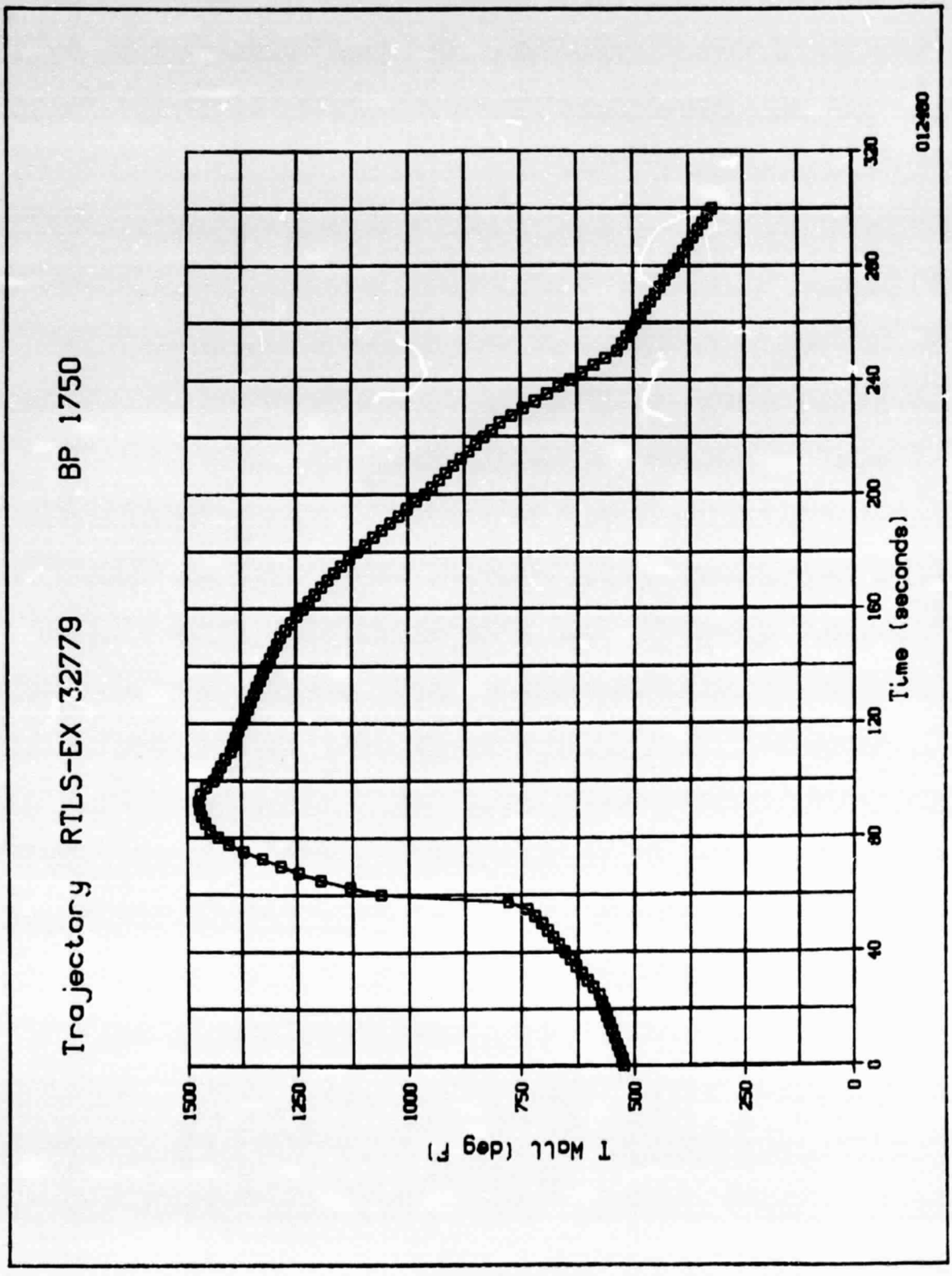
ORIGINAL PAGE IS
OF POOR QUALITY




Trajectory RTLS-EX 32779 BP 1750
Local Reynolds Nos./1.0E6
75
62.5
50
37.5
25
12.5
0
0
40
80
120
160
200
240
280
320
Time (seconds)


Trajectory RTLS-EX 32779 BP 1750
Local Pressure (lbf/ft-sq)
120
100
80
60
40
20
0
0
40
80
120
160
200
240
280
320
Time (seconds)
012480




Trajectory RTLS-EX 32779 BP 1750
T Wall (deg F)
1500
1250
1000
750
500
250
0
0
40
80
120
160
200
240
280
320
Time (seconds)
012480

8. COMPUTER PROGRAMS LISTING

```
      C
      CCC   MINIATURE VERSION OF JA70 (MINIVER)
      C
            INTEGER BDYPNT,TRANME,DEVICE
            PARAMETER J2=500
            DIMENSION TIME1(J2),XME1(J2),REL1(J2),QC1(J2),QC1T(J2),
           1TREF1(J2),TW1(J2),PE1(J2),CP1(J2),BETA1(J2),ALPHA1(J2),AKLZ1(J2)
           2,HFACZ1(J2),QT(2),TT(2),CPS(J2),TW2(J2)
            DIMENSION TRAJ(2,2),FFRI(3),ALFARI(3)
            DATA ((TRAJ(I,J),I=1,2),J=1,2)/12H26BP-14414-1,12H26BP-OFT-1N /     RI
            DIMENSION  FF(9),QQ(10)
            DIMENSION   RR(10),  SS(10)
            DIMENSION LABEL(20,6)
            DIMENSION T(25) ,T11(25),DX    (25),MPFLAG  (25),RHOZ  (25),
           1 CPZ   (25),COND2 (25),NTAB  ( 5),TIUZ  (50),HCIUZ (50),
           2 TQASZ (50),TSINKZ(50)
            DIMENSION TABT(10,5),TABCP(10,5),TABCX(10,5)
            DIMENSION TABT1(10),TABT2(10),TABT3(10),TABT4(10),TABT5(10),
           1 TABCP1(10),TABCP2(10),TABCP3(10),TABCP4(10),TABCP5(10),
           2 TABCX1(10),TABCX2(10),TABCX3(10),TABCX4(10),TABCX5(10)
            COMMON/DIBUJO/BDYPNT(4),TRANME(6),ICASE
      C
            COMMON/LABS/LABEL
      C     COMMON BLOCK USED TO TRANSFER INPUT DATA TO URINP
      CC          AND SETUP ROUTINES
      C
            COMMON/COMUN/T1,DT1,T2,DT2,T3,DT3,T4,DTCALC,DTEMAX,ATFLAG,HTFLAG,
           1 RN,EL,PARA1,ENL,ENT,PHI,AKL,AKT,PARA2,EMATL,DEL,EMIS,TIN,RHOM,
           2 CPM,TRFLAG,ELFAC,URLFLG,ATRE,GF(6),ALFA(9),HH(3),HFAC,ENTR,
           3 TZ(50),ZZ(50),UZ(50),CFFLG,DSUBO,ELMBDA,UDOT,CORNR,IOPT,CONFLG,
           4 ENT1,TA(10),A1(10),A2(10),A3(10),A4(10),A5(10),A6(10),A7(10),
           5 A8(10),A9(10),NTFAC,OUTPUT,REIRO,REIRIM,LNGPLT,ENVIR,RANFLG,ENT2,
           6 TK1(10),AKL2(10),AKT2(10),TK2(10),ENM3,TMACH(10),AKL3(10),
           7 AKT3(10),HFACT(9),ARIDEF,ALFA0T(50),DELTAT(50),FSPRES(50),
           8 ARIQ,ALFA1,AKL2Z1,HSLP1,ALFA2,AKL2Z2,HSLP2,HSLP3,ARIR,ENT3,
           9 TM2(10),RN2(10),EL2(10),PHIZ(10),EMIZ(10),ALFA1R,REFAC1,RSLP1,
           * ALFA2R,REFAC2,RSLP2,RSLP3,ARIT,ALFA1T,ENMTL,TMAT(10),CPMAT(10),
           * PARA11,PSLP1,ALFA2T,PARA12,CPSLP2,PSLP2,PSLP3,ARIC,ALFA1C,CPCPS1,
           * CPSLP1,ALFA2C,CPCPS2,CPSLP3,ENALT2,FSALT(50),FSTEMP(50),
           * NTAB1,NTAB2,NTAB3,NTAB4,NTAB5,TABT1,TABT2,TABT3,TABT4,TABT5,
           * TABCP1,TABCP2,TABCP3,TABCP4,TABCP5,TABCX1,TABCX2,TABCX3,
           * TABCX4,TABCX5
      C
      CCC     INPUT/OUTPUT DESCRIPTION OF NAMELIST
      C
            NAMELIST/DATALO/T1,DT1,T2,DT2,T3,DT3,T4,DTCALC,DTEMAX,ATFLAG,
           1 HTFLAG,RN,EL,PARA1,ENL,ENT,PHI,AKL,AKT,PARA2,EMATL,DEL,
           2 EMIS,TINC,RHOM,CPM,TRFLAG,ELFAC,URLFLG,ATRE,GF,ALFA,HH,
           3 HFAC,ENTR,TZ,ZZ,UZ,CFFLG,DSUBO,ELMBDA,UDOT,CORNR,IOPT,
           4 TOPT,PERCNT,CONFLG,ENT1,TA,A1,A2,A3,A4,A5,A6,A7,A8,A9,NTFAC,
           5 NFF,OUTPUT,REIRO,REIRIM,LNGPLT,ENVIR,RANFLG,ENT2,TK1,AKL2,
           6 AKT2,TK2,ENM3,TMACH,AKL3,AKT3,HFACT,ARIDEF,ALFA0T,DELTAT,
```

```
     7 ARIG,ALFA1,AKLEZ1,HSLP1,ALFA2,AKL2Z2,HSLP2,HSLP3,ARIR,
     8 ENT3,TM2,RN2,EL2,PHIZ,EMIZ,ALFA1R,REFAC1,RSLP1,ALFA2R,
     9 REFAC2,RSLP2,RSLP3,ARIT,ALFA1T,ENMTL,TMAT,RNMAT,PARA11,
     $ PSLP1,ALFA2T,PARA12,PSLP2,PSLP3,ARIC,ALFA1C,CPCPS1,
     $ NODES,DX,T,MPFLAG,RHOZ,CPZ,CONDZ,NTAB,CPSLP1,
     $ ALFABC,CPCPS2,CPSLP2,CPSLP3,TSINK,FIU,HCIU,TGAS,
     $ NTIUZ,TIUZ,HCIUZ,TGASZ,TSINKZ,ENALTZ,
     $ FSALT,FSTEMP,FSPRES,LNQPLT,MAXTME,BDYPNT,TRANME,IPLTUE,ICASE,
     $ IFLGOT,IMCOPY,IBPNUM,NTAB1,NTAB2,NTAB3,NTAB4,NTAB5,
     $ TABT1,TABT2,TABT3,TABT4,TABT5,TABCP1,TABCP2,
     $TABCP3,TABCP4,TABCP5,TABCX1,TABCX2,TABCX3,TABCX4,TABCX5
C
C      COMMON BLOCK DIBUJO USED IN PLOTLO AND DRAW ROUTINES
CCC
CCC
CCC
C
      COMMON/FLUFLD/TINF,PINF,RHOINF,AINF,RHOE,PE,TE,HE,XMUE,UE,RHOO,PO,
     1TO,HO,XMUO,RHOU,TU,HU,XMUU,RHOS,TS,HS,XMUS,RHOR,TR,HR,XMUR,U,XME
     2,REL,HINF,XMUINF,PR,PU,DU,TU,XMUU,XMACHU,UU,HU, ALPHA,
     3RHOSTL,HSTL,TSTL,XMUSTL,RHOSTT,HSTT,TSTT,XMUSTT,HRECL,HRECT,S
     $,GINF,GAMAU,GAMAS,GAMAE,GAMAO,GU,GAMAG,PRL,PRT
C
CC
      COMMON/HANDY/IMAX,DX,T,MPFLAG,NTIUZ,TSYNK,EMISIN,HCIU,TGSF,TIUZ,
     1HCIUZ,TGASZ,TSINKZ,TWI,TSINK,TGAS,HCIN,IFIRST,DELT
      COMMON/DNSTRM/TD,PD,DD,XMD,UD,SD,HD,AD,GAMAD
C
      COMMON/ THICK/ DTEQ, TDOT, TRE, QC, QR, ENC, EMISS, HRECOV,
     1 DT, TIME, PL, DTO, DTI, TEQ2
      COMMON/ERRFLG/NERROR
      COMMON/FLAG/ IDEAL,IFP
      COMMON/NFLAG/ NNFLAG
      COMMON/OPTT/                TOPT,PERCNT,DELO,TI,
     1          SIGMA, EMMY, MATL, NMTL, ROOM, CNN, ICANT, ITRIED
      COMMON/ARRAY/QC1,TIME1,BETA1,ALPHA1,AKLZ1,
     $HFACZ1,XME1,REL1,PE1,CP1,TW1,TREF1,QT,TT,TW2,QC1T
      COMMON/MAX/QM,BETAM,AKLZM,HFACZM,PEM,CPPM,TREFM
      COMMON/PLOTT/JRCD,IT,NT,NT2,NFF,PCT
      COMMON/FFNUM/NSUBD,ALEW
      COMMON/PROPS/ RHOZ, CPZ, CONDZ, TABT, TABCP, TABCX,NTAB
      DATA ISAVED/ 0/, ITRIED/ 0/
C
CC
CC      DEFINE PLOT LABELS
C
      DATA (LABEL( 1,J),J=1,6)/36H (A)LTITUDE (()FEET)$                  /
      DATA (LABEL( 2,J),J=1,6)/36H (V)ELOCITY (()FT/SEC)$                /
      DATA (LABEL( 3,J),J=1,6)/36H (A)LPHA (()DEGREES)$                  /
      DATA (LABEL( 4,J),J=1,6)/36H (L)AMINAR (F)ACTORS$                  /
      DATA (LABEL( 5,J),J=1,6)/36H (D)EFLECTION (F)ACTORS$               /
      DATA (LABEL( 6,J),J=1,6)/36H (L)OCAL (M)ACH (N)UMBERS              /
      DATA (LABEL( 7,J),J=1,6)/36H (L)OCAL (R)EYNOLDS (N)OS./1.0(E)6$    /
      DATA (LABEL( 8,J),J=1,6)/36H (R)EFACS                              /
      DATA (LABEL( 9,J),J=1,6)/36H (L)OCAL (P)RESSURE (()LBF/FT-SQ)$     /
      DATA (LABEL(10,J),J=1,6)/36H (C) PS                                /
      DATA (LABEL(11,J),J=1,6)/36H (Q) (D)OT ((B)TU/FT-SQ-SEC)$          /
      DATA (LABEL(12,J),J=1,6)/36H (T) (U)ALL (()DEG (F))$               /
      DATA (LABEL(13,J),J=1,6)/36H (C)ONTROL (S)URFACE DEF.(()DEG.)$     /
```

```
      DATA (LABEL(14,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)8  /
      DATA (LABEL(15,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)8  /
      DATA (LABEL(16,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)8  /
      DATA (LABEL(17,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)8  /
      DATA (LABEL(18,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)8  /
      DATA (LABEL(19,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)8  /
      DATA (LABEL(20,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)8  /
      DEFINE FILE 10(300,80,E,JRCD)
C
CC      DEFINE DEVICE BEING USED WHILE ON DEMAND TERMINAL
C
      EMISIN=FIW
      CALL MENULO(DEVICE)
      SIGMA=4.75892E-13
      PARA12=0.
      DELM=0.
      FIW=0.
      TSINKZ(1)=0.
      TGASZ(1)=0.
      HCIWZ(1)=0.
      TIWZ(1)=0.
      REWIND 3
      REWIND 4
      CALL ERTRAN(6,'@ASG,T 15.')
      CALL ERTRAN(6,'@USE 15,15')
    3 CONTINUE
      IPAGE=0
      IF(ICASE .EQ. 0) GO TO 21
      WRITE(6,26) QM,TIMEQ,TWIM,TIMET
   26 FORMAT(//' QC MAX='F7.2,'  TIME='F7.0//' TW MAX='F7.0,'  TIME='
     *F7.0)
C     IF (OUTPUT-1) 21,23,24
C23   PUNCH 350, (TRAJ(I,J), I=1,2), M(3)
C     PUNCH 355, (TIME1(I),QC1(I), I=1,IT,10)
C     PUNCH 360, (TRAJ(I,J), I=1,2), M(3)
C     PUNCH 365, (TIME1(I),PE1(I), I=1,IT,10)
C     GO TO 21
C24   WRITE(15,350) (TRAJ(I,J), I=1,2), M(3)
C     WRITE(15,355) (TIME1(I),QC1(I), I=1,IT,10)
C     WRITE(15,360) (TRAJ(I,J), I=1,2), M(3)
C     WRITE(15,365) (TIME1(I),PE1(I), I=1,IT,10)
C350  FORMAT (24X,2A6,' CASE',I3,'   QDOT RAD EQ')
C355  FORMAT (F6.0,F7.3)
C360  FORMAT (24X,2A6,' CASE',I3,'   LOCAL PRESSURE')
C365  FORMAT (F6.0,F6.1)
   21 CONTINUE
      CALL ZERONL
C
CC    READ DATA
C
      READ(5,DATALO,END=998)
      ITINIT=TINC
      CALL TABPRO(NTAB1,NTAB2,NTAB3,NTAB4,NTAB5,TABT1,TABT2,
     1 TABT3,TABT4,TABT5,TABCP1,TABCP2,TABCP3,TABCP4,TABCP5,
     2 TABCX1,TABCX2,TABCX3,TABCX4,TABCX5,TABT,TABCP,TABCX,NTAB)
    7 CONTINUE
      MT=ENTR+.001
      MT3=ENT3+.001
```

```
      NT3=ENT3+.001
      NATL=ENATL+.001
      NT1=ENT1+.001
      NT2=ENT2+.001
      NHFLAG=HTFLAG+.001
      NCFLG=CFFLG+.001
      ROOM = RHOM
      EMMY = EMIS
      CMM = CPM
      DELO = DEL
      ITHICK=0
      MPRINT=1
      MATL=EMATL+.001
      IF(AKL.LE.0.) AKL=1.
      IF(AKT.LE.0.) AKT=1.
      IF (HFAC .LE. 0) HFAC=1.
      IF(ENL.LE.0.) ENL=1.
      IF(ENT.LE.0.) ENT=1.
      IF(PARA2.LE.0.) PARA2=PARA1
      AKL2Z=1.
      AKT2Z=1.
      AKT3Z=1.
      AKL3Z=1.
      HFAC1=1.
      IF(EMIS.LE.0.) EMIS=.0001
      IF(DTCALC.LE.0.) DTCALC=0.2
      IF (NODES .GT. .001) ITHICK = 1
  200 DO 301  K = 1, 9
      IF(K.GT.6) GO TO 302
      FF(K)=GF(K)
      GO TO 301
  302 FF(K)=HH(K-6)
  301 CONTINUE
C
CC    WRITE OUT INPUT DATA
C
 1000 CALL WRINP(NODES,NFF)
      IF (ITHICK .EQ. 0) GO TO 304
      EMISS = EMIS
      DO 2013 MMM=1,25
 2013 T11(MMM)=T(MMM)
      CALL SETMUP(TSINK,FIW,HCIW,TGAS,NTIWZ,NODES,
     1 TIWZ,TGASZ,TZK,DX,T11,MPFLAG)
      IF (IOPT .NE. 0) WRITE (6,8138)
 8138 FORMAT(1H ,//62H OPTIMIZATION CAN NOT PRESENTLY BE DONE WITH A THI
     1CK SKIN CASE//)
      IOPT = 0
  304 CONTINUE
C
CC    CHECK FOR MISSING INPUTS
C
      IF(DEL.LE.0..AND.NODES.LE.0.) GO TO 499
      IF(NHFLAG.LE.0) GO TO 509
      IF(NHFLAG.LE.2)GO TO 501
      IF(NHFLAG.LE.5)GO TO 506
      IF(NHFLAG.LE.8)GO TO 501
  509 WRITE(6,510) NHFLAG
  510 FORMAT(/21H HEAT TRANSFER OPTION,I3,26H IS A NO-NO. CASE ABORTED.)
```

```
      NERROR=1
      GO TO 3
  501 IF(RM.LE.0..AND.RM2(1).LE.0.) GO TO 502
      IF(NHFLAG.EQ.1.OR.NHFLAG.EQ.7) GO TO 400
      IF(PHI.LE.0..AND.PHI2(1).LE.0.) GO TO 504
      IF(NHFLAG.LT.8) GO TO 400
  506 IF(EL.LE.0..AND.EL2(1).LE.0.) GO TO 507
      GO TO 400
  489 WRITE(6,500)
  500 FORMAT(/51H MATL THICK. INPUT IS UNACCEPTABLE. CASE DISMISSED.)
      NERROR=1
      GO TO 3
  502 WRITE(6,503)
  503 FORMAT(/51H YOUR RADIUS INPUT IS UNACCEPTABLE. CASE DISMISSED.)
      NERROR=1
      GO TO 3
  504 WRITE(6,505)
  505 FORMAT(/51H YOUR  PHI   INPUT IS UNACCEPTABLE. CASE DISMISSED.)
      NERROR=1
      GO TO 3
  507 WRITE(6,508)
  508 FORMAT(/51H YOUR LENGTH INPUT IS UNACCEPTABLE. CASE DISMISSED.)
      NERROR=1
      GO TO 3
C
C     INITIALIZE PARAMETERS
C
  400 IF(NERROR.EQ.0) GO TO 401
      IF(CONFLG.LT..001) GO TO 401
      WRITE(6,402)
  402 FORMAT(///63H AN ERROR IN THE PREVIOUS CASE RENDERS THIS CASE USEL
     1ESS, ALSO.    )
      GO TO 3
  401 TIME=T1
      NERROR=0
      IFP=0
      IT=1
      IFIRST = 1
      NSTEP = 1
      TS=0.
      HS=0.
      RHOS=0.
      XMUS=0.
      TR=0.
      HR=0.
      RHOR=0.
      XMUR=0.
      ALEU=0.
      HSUBD=0.
      ENCTO=0.
      ELTRAN=0.
      PARA=0.
      OPT=T1
      SD=0.
      QR=0.
      TW1M=0.
      TREFM=0.
      CPPM=0.
```

```
      PEM=0.
      AKLEM=0
      HFACZM=0.
      BETAM=0.
      DO 403 I=1,2
      QT(I)=0.
  403 TT(I)=0.
      IF(CONFLG.GT.0.001) GO TO 4
      TU=TINC+459.7
      TI = TU
      QCTOT=0.
      QRETOT=0.
      QTOT=0.
      QCCUT=0.
C
CCC
CCC   INITIALIZE OPTIMIZATION CONDITIONS IF OPTIMIZATION IS CALLED FOR
CCC   AND IF THIS IS THE FIRST CASE.
CCC
C
      IF (IOPT .GT. 0 .AND. MOD(ISAVED,2) .NE. 1) CALL OPTMYZ(0)
      IF(IOPT.EQ.0.AND.ENVIR.GT.0.) CALL OPTMYZ(0)
C
CCC   BEGIN CALCULATION LOOP
C
    4 CONTINUE
      IF (ITHICK .NE. 1) GO TO 1500
      IF (IFIRST .EQ. 1) GO TO 1500
      IF (NSTEP .EQ. 1 .OR. NSTEP .EQ. 3) GO TO 1800
 1500 IF (ATFLAG .GT. 0) GO TO 12
      CALL TBLIN(TIME ,TZ,Z,ZZ,U,UZ,NT)
      CALL AIR62(Z,TINF,RHOINF,PINF,AINF)
      GO TO 15
   11 CALL ATMS4(Z,TINF,RHOINF,PINF,AINF)
      GO TO 15
   12 IF(ATFLAG.GT.1.1) GO TO 14
      CALL TINT6(TIME,TZ,U,UZ,TINF,FSTEMP,PINF,FSPRES,QRG,QQ,RRG,RR,SSG,
     1SS,0,NT)
   13 IF(TINF.LE.0.) GO TO 16
      RHOINF=PINF/(1716.483*TINF)
      AINF=SQRT(1.4*1716.483*TINF)
      GO TO 15
   16 WRITE(6,17)
   17 FORMAT(/39H INPUT FREESTREAM TEMP IS ZERO OR NEG.  /)
      NERROR=1
      GO TO 3
   14 CALL TBLIN(TIME ,TZ,Z,ZZ,U,UZ,NT)
      IF(ATFLAG.GT.3.1) GO TO 11
      CALL TBLIN(Z,FSALT,TINF,FSTEMP,PINF,FSPRES,NALTZ)
      GO TO 13
   15 IF(NT1.LE.0) GO TO 303
      CALL TINT6(TIME,TA,ALFA(1),A1,ALFA(2),A2,ALFA(3),A3,ALFA(4),A4,
     1ALFA(5),A5,ALFA(6),A6,0,NT1)
      IF(FF(7).GT.0.) CALL TINT6(TIME,TA,ALFA(7),A7,ALFA(8),A8,ALFA(9),
     1A9,QRG,QQ,RRG,RR,SSG,SS,0,NT1)
      GO TO 306
  303 IF (NFF .EQ. 0) GO TO 306
      CALL TBLIN(TIME,TZ,ALFA0,ALFA0T,QRG,QQ,NT)
```

```
      IF (NFF .EQ. 1) GO TO 306
      ALFA(1)=ALFA0+PHI
      IF (ALFA(1) .LT. 0.) ALFA(1)=0.001
      ALFA(2)=ALFA0+PHI
      IF (ALFA(2) .LT. 0.) ALFA(2)=0.001
  306 CALL FLOW(FF,ALFA,BETA)
      IF(NERROR.NE.0) GO TO 3
      IF(NT3.LE.0) GO TO 18
      CALL TINT6(TIME,TM2,RNA,RNZ,ELA,ELZ,PHIA,PHIZ,EMIA,EMIZ,RRQ,RR,
     1SSQ,SS,6,NT3)
      IF(RNA.GT.0.) RN=RNA
      IF(ELA.GT.0.) EL=ELA
      IF(PHIA.GT.0.)PHI=PHIA
      IF(EMIA.GT.0.) EMIS=EMIA
   18 ELL=EL
      ELT=EL
      IF(CFFLG.GT.0.) CALL CRSFLW(CFFLG,ELL,ELT,EL,ELMBDA,DSUBO,CORNR,
     1 UE, PE, RHOE, PU, ALPHA, UDOT, UU,XMACHU,UX)
      ELTP=ELT
      IF(NHFLAG.LT.3.OR.NHFLAG.GT.5) GO TO 19
      IF(URLFLG.LE.0.) GO TO 19
      IF(TRFLAG.LT.3.) GO TO 19
      CALL URUNL(TRFLAG,ELTRAN,ELL,ELT,ELTP,PARA1,PARA2,ENL,EL,UX,
     1 NCFLG)
   19 IF(NHFLAG-2)10,20,5
    5 IF(NHFLAG-4 )30,40,6
    6 IF(NHFLAG-6 )50,60,8
    8 IF(NHFLAG-8 )70,80,80
C
CC    DETERMINE HEAT TRANSFER COEFFICIENT
C
   10 CALL FAYRID(RN,ENCLO)
      IF(NERROR.NE.0) GO TO 3
      GO TO 100
   20 CALL SUCYL(RN,PHI,ENCLO,ENCTO)
      IF(NERROR.NE.0) GO TO 3
      GO TO 100
   30 CALL ECKERT(ELL,ELT,ENL,ENT,ENCLO,ENCTO)
      IF(NERROR.NE.0) GO TO 3
      GO TO 100
   40 CALL SPCHI(ELL,ELT,ENL,ENT,ENCLO,ENCTO,  RANFLG)
      IF(NERROR.NE.0) GO TO 3
      GO TO 100
   50 CALL RHOMUR(ELL,ELT,ENCLO,ENCTO)
      IF(NERROR.NE.0) GO TO 3
      GO TO 100
   60 CALL SUCYL2(RN,PHI,ENCLO,ENCTO)
      IF(NERROR.NE.0) GO TO 3
      GO TO 100
   70 CALL SUCYL3(RN,ENCLO,ENCTO)
      IF(NERROR.NE.0) GO TO 3
      GO TO 100
   80 CALL DETRAL(RN,EL,PHI,ENCLO,ENCTO)
      IF(NERROR.NE.0) GO TO 3
      GO TO 100
C
CC    CALCULATE VARIABLE FACTORS FOR HEAT TRANSFER COEFFICIENT
C
```

```
  100 IF (NT2 .GT. 0)
     *CALL TBLIN(TIME,TK1,AKL2Z,AKL2,AKT2Z,AKT2,NT2)
      IF (NM3 .GT. 0)
     *CALL TBLIN(XMACHU,TMACH,AKL3Z,AKL3,AKT3Z,AKT3,NM3)
      IF (NTFAC .GT. 0)
     *CALL TBLIN(TIME,TK2,HFAC1,HFACT,QRG,QQ,NTFAC)
C                                                                       RI
CC    RI DEFLECTION FACTOR AS FUNCTION OF ALPHA AND DELTA               RI
C                                                                       RI
      IF (ARIDEF .LT. .001) GO TO 1004                                  RI
      CALL TBLIN(TIME,TZ,DELTA0,DELTAT,QRG,QQ,NT)                       RI
      IF (DELTA0 .GT. 1.) GO TO 1040                                    RI
      GAMMA=.0125*DELTA0-.0051                                          RI
      GO TO 1047                                                        RI
 1040 IF (DELTA0 .GT. 4.) GO TO 1041                                    RI
      GAMMA=.0196*DELTA0-.0122                                          RI
      GO TO 1047                                                        RI
 1041 IF (DELTA0 .GT. 8.) GO TO 1042                                    RI
      GAMMA=.02765*DELTA0-.0443                                         RI
      GO TO 1047                                                        RI
 1042 IF (DELTA0 .GT. 15.) GO TO 1043                                   RI
      GAMMA=.03676*DELTA0-.11758                                        RI
      GO TO 1047                                                        RI
 1043 GAMMA=.04669*DELTA0-.2665                                         RI
 1047 HFAC1=1.05+(9.8-ALFA0/5)*GAMMA                                    RI
      IF (GAMMA .LT. 0.) HFAC1=1.                                       RI
      FFRI(1)=FF(1)                                                     RI
      ALFARI(1)=ALFA+DELTA0                                             RI
      FFRI(2)=FF(2)                                                     RI
      ALFARI(2)=ALFA+DELTA0                                             RI
C                                                                       RI
CC    RI LAMFAC OR H/H FACTOR AS FUNCTION OF ALPHA                      RI
C                                                                       RI
 1004 IF (ARIQ .LT. .001) GO TO 1014                                    RI
      IF (ALFA0 .GT. ALFA1) GO TO 1005                                  RI
      AKL2Z=AKL2Z1-HSLP1*(ALFA1-ALFA0)                                  RI
      GO TO 1014                                                        RI
 1005 IF (ALFA0 .GT. ALFA2) GO TO 1010                                  RI
      AKL2Z=AKL2Z2-HSLP2*(ALFA2-ALFA0)                                  RI
      GO TO 1014                                                        RI
 1010 AKL2Z=AKL2Z2+HSLP3*(ALFA0-ALFA2)                                  RI
 1014 IF (AKL2Z .LT. 0.) AKL2Z=0.                                       RI
C                                                                       RI
CC    RI REFAC AS FUNCTION OF ALPHA AND LOCAL REL                       RI
C                                                                       RI
 1015 IF (ARIR .LT. .001) GO TO 1035                                    RI
      REIRI=RHOINF*U/XMUINF/.0175                                       RI
      IF (ALFA0 .GT. ALFA1R) GO TO 1020                                 RI
      REFAC=REFAC1-RSLP1*(ALFA1R-ALFA0)                                 RI
      GO TO 1030                                                        RI
 1020 IF (ALFA0 .GT. ALFA2R) GO TO 1025                                 RI
      REFAC=REFAC2-RSLP2*(ALFA2R-ALFA0)                                 RI
      GO TO 1030                                                        RI
 1025 REFAC=REFAC2+RSLP3*(ALFA0-ALFA2R)                                 RI
 1030 IF (REIRI .LE. REIRIO) HFAC1=1.                                   RI
      IF (REIRI .GE. REIRIM) HFAC1=REFAC                                RI
      IF (REIRI .GT. REIRIO .AND. REIRI .LT. REIRIM)                    RI
     *HFAC1=1.+(REIRI-REIRIO)/(REIRIM-REIRIO)*(REFAC-1.)                RI
```

```
      IF (HFAC1 .LT. 1.) HFAC1=1.
 1035 CONTINUE                                                          RI
      HFAC2=HFAC1*HFAC1                                                 RI
      AKLZ=AKL*AKL2Z*AKL3Z
      AKTZ=AKT*AKT2Z*AKT3Z
      ENCL=ENCLO*AKLZ*HFAC2
      ENCT=ENCTO*AKTZ*HFAC2
C
C     DETERMINE TRANSITION
C
      IF (AKLZ .LE. 0.) GO TO 1060
      IF (TRFLAG .EQ. 8)
     *PARA=.664/AKLZ*SQRT(RHOSTL*XMUSTL*REL/(RHOE*XMUE*ENL))/XME       RI
      IF (ARIT .LT. .001) GO TO 1060                                    RI
      IF (ALFA0 .GT. ALFA1T) GO TO 1050                                 RI
      PARA1=PARA11-PSLP1*(ALFA1T-ALFA0)                                 RI
      GO TO 1060                                                        RI
 1050 IF (ALFA0 .GT. ALFA2T) GO TO 1055                                 RI
      PARA1=PARA12-PSLP2*(ALFA2T-ALFA0)                                 RI
      GO TO 1060                                                        RI
 1055 PARA1=PARA12+PSLP3*(ALFA0-ALFA2T)                                 RI
 1060 CONTINUE                                                          RI
      CALL TRANS(ENCL,ENCT,PARA1,PARA2,PARA,TIME,ENC,HRECOV,MTR,PCT,    RI
     *TRFLAG,EL,ELFAC,ENL,ELL,NCFLG,UX,AKLZ,ITRAN,IBPNUM)
      IF(NERROR.NE.0) GO TO 3
      IF (ITHICK .EQ. 0) GO TO 1200
      PL = PE
 1800 CALL CHEEUV(NSTEP)
      IF(NERROR.GT.0) GO TO 3
      QRE=SIGMA*EMIS*TRE**4
      QN = QC - QR
      QCCU = ENC * HRECOV
      GO TO 1300
C
C     DETERMINE RADIATION EQUILIBRIUM TEMPERATURE
C
 1200 CONTINUE
      IF (ATRE .GT. .001) GO TO 1205
      IF (HRECOV .LE. HW) GO TO 1210
 1205 CALL RADEQT(ENC,HRECOV,EMIS,TW,PE,TRE)
 1210 CONTINUE
C
C     CALCULATE HEAT RATES, THIN SKIN TEMPERATURE RESPONSE PARAMETER
C
      QC=ENC*(HRECOV-HW)
      QRE=SIGMA*EMIS*TRE**4
      IF (ATRE .LT. .001) GO TO 1225
      TW=TRE
      QC=QRE
      IF (IDEAL .EQ. 0) GO TO 1215
      HW=.24*TW
      GW=1.4
      RHOW=PE/TW/32.17/53.35
      GO TO 1220
 1215 CALL MOLIER(HW,PE,2,TW,ZZZ,SSS,RHOW,GW)
 1220 CALL HANSEN(XMUW,PE,TW)
 1225 CONTINUE
      QR=SIGMA*EMIS*TW**4
```

```
      QM=QC-QR
      QCCU=ENC*RECOU
      CALL MATRES(MATL,QM,RHOM,CPM,DEL,TDOT,TW,TMAT,CPMAT,MMTL)
 1300 CONTINUE                                                          RI
C                                                                       RI
C     RI CP/CP SPHERE AS FUNCTION OF ALPHA                              RI
C                                                                       RI
      IF (ARIC .LT. .001) GO TO 1095                                    RI
      IF (ALFA0 .GT. ALFA1C) GO TO 1080                                 RI
      CPCPS=CPCPS1-CPSLP1*(ALFA1C-ALFA0)                                RI
      GO TO 1090                                                        RI
 1080 IF (ALFA0 .GT. ALFA2C) GO TO 1085                                 RI
      CPCPS=CPCPS2-CPSLP2*(ALFA2C-ALFA0)                                RI
      GO TO 1090                                                        RI
 1085 CPCPS=CPCPS2+CPSLP3*(ALFA0-ALFA2C)                                RI
 1090 FFRI(1)=FF(1)                                                     RI
      ALFARI(1)=ALFA(1)                                                 RI
      FFRI(2)=14.                                                       RI
      ALFARI(2)=CPCPS*CPS(IT)                                           RI
 1095 IF (ARIDEF .LT. .001 .AND. ARIC .LT. .001) GO TO 1100             RI
      ALFARI(3)=0.                                                      RI
      FFRI(3)=0.                                                        RI
      ALPHAS=ALPHA                                                      RI
      CALL FLOW(FFRI,ALFARI,BETARI)                                     RI
      ALPHA=ALPHAS                                                      RI
 1100 CONTINUE                                                          RI
C*************************************************************************
C                                                                       *
C           STORAGE ARRAYS                                              *
C                                                                       *
C*************************************************************************
      IF (IT .LE. J2) GO TO 1120
      IF (IT .EQ. J2) WRITE(6,1110) IT
 1110 FORMAT('0*********************ITERATION COUNTER EQUALS',I4,';ARRAYS NO
     *LONGER BEING LOADED*****************')
      GO TO 83
 1120 CONTINUE
      TIME1(IT)=TIME
      QC1(IT)=QC
      IF (QC .GT. QM) TIMEQ=TIME
      QM=MAX(QM,QC)
      TWF=TW-459.7
      TW1(IT)=TWF
      IF (TWF .GT. TW1M) TIMET=TIME
      TW1M=MAX(TW1M,TWF)
      IF (U .NE. 0) CP=(PE-PINF)/(.5*RHOINF*U**2)
C     IF (M(2) .EQ. 1 .AND. M(3) .EQ. 2) CPS(IT)=CP                     RI
C     IF (M(2) .EQ. 1) GO TO 83                                         RI
      XME1(IT)=XME
      REL1(IT)=REL/1.E6
      TREF1(IT)=TRE-459.7
      TREFM=MAX(TREFM,TREF1(IT))
      TW8(IT)=T(IMAX)-459.7
      PEM=MAX(PEM,PE)
      PE1(IT)=PE
      CP1(IT)=CP
      CPPM=MAX(CPPM,CP)
      BETA1(IT)=BETA
```

```
      BETAM=MAX(BETAM,BETA)
      AKL21(IT)=AKL2
      AKL2M=MAX(AKL2M,AKL2)
      HFAC21(IT)=HFAC2
      HFAC2M=MAX(HFAC2M,HFAC2)
      ALPHA1(IT)=ALPHA
   83 CONTINUE
C
CCC         ITRAN  IS A FLAG TO INDICATE POINT OF LAMINAR/TRANSITION OR
CCC                TRANSITION/TURBULENT FLOW FOR PRINTOUT AND PLOTTING.
CCC                ITRAN=0     NO CHANGE IN TYPE OF FLOW
CCC                ITRAN=1     CHANGE IN TYPE OF FLOW
C
      IF (ITRAN .NE. 1) GO TO 1904
      IF (PCT .GE. 1.) GO TO 1902
      WRITE (6,1901)
1901  FORMAT(' **********  TRANSITION ONSET  **********')
PARA=PAR1
    IF (PCT .GT..00) PARAO=PARA2
      IF ITRN .EQ.  .AND PCT.LT1.) PRAO=PARA1
      UMAX=SQRT(50103*HO)
      TAUU = ENC * S * UE / 3[illegible]
      IF(IFP.GT.0) WRITE(6,207)
  207 FORMAT(/1X,56H**/DEAL GAS EQUATIONS HAVE BEEN USED BETWEEN PRINTOU
     1TS**)
      IFP=0
C
C     CALL OUTPUT ROUTINE IF FLAG SET
C
      IF(IFLGOT .EQ. 0 ) GO TO 90
  712 CONTINUE
      CALL NEWOUT(TOF,CFO2,TUF,TAUU,RED,TDF,Z,XMINF,FF,
     1 ELT,REE,RETHML,ENCLO,AKLZ,QCTOT,QRE,ELTRAN,CPS,RR,SS,
     2 REI,TEF,DELTAS,QCL,AKL2Z,AKL3Z,THETA,PARAO,HFAC1,ELTP,
     3 TINFF,STANT,BETA,CP,TUF,REU,RES,TSF,TRF,ELL,XMUD,TREF,
     4 TRECOV,REO,DELTA,AKT2Z,HFAC2,QRETOT,QNTOT,QCCU,
     5 QN,QCCUT,H,ENCTO,QCTU,AKT3Z,AKTZ,IPAGE)
   90 CONTINUE
      IF (ITHICK .EQ. 0) GO TO 107
      CALL PRINT1
      GO TO 109
  107 CONTINUE
       WRITE(6,205) TEMP
  205 FORMAT(/22H TEMPERATURE (DEG F) =F9.2/)
  109 CONTINUE
      IF (TIME+1.000001-OPT) 116
      IF (TIME+1.000001-T2) 110,113,113
  110 TIME=OPT
      OPT=OPT+DT1
      IF(OPT.GT.T2) OPT=T2
      DT=DTCALC+DT1
      DTC = DT
      GO TO 116
  112 TIME=OPT
      OPT=OPT+DT2
      IF(OPT.GT.T3) OPT=T3
      DT=DTCALC+DT2
      DTC = DT
```

```
  113 IF (TIME#(1.000001)-T3) 112,115,115
  114 TIME=OPT
      OPT=OPT+DT3
      IF(OPT.GT.T4) OPT=T4
      DT=DTCALC#DT3
      DTC = DT
      GO TO 116
  115 IF (TIME#(1.000001)-T4) 114,160,160
  116 IF (ITHICK .EQ. 0) GO TO 140
      IF (IFIRST .EQ. 0) GO TO 1700
      IFIRST = 0
      GO TO 1600
 1700 NSTEP = NSTEP + 1
      IF (NSTEP .EQ. 2 .OR.NSTEP .EQ. 4) TIME = TIME + DT/2.
      IF (NSTEP .LT. 5) GO TO 4
      NSTEP = 1
 1600 CONTINUE
      DT=AMIN1(DTC,DTEQ)
      GO TO 118
  140 DT=DTC
      IF (ABS(TRE-TW) .LT. .001 .OR. TDOT .EQ. 0.) GO TO 118
      IF (DTEMAX .LE. 0.) GO TO 119
      DTMAX=ABS(DTEMAX/TDOT)
      IF(DT.GT.DTMAX) DT=DTMAX
  119 DTTRE=0.9#(TRE-TW)/TDOT
      IF(DTTRE.GT.0..AND.DTTRE.LT.DT) DT=DTTRE
  118 IF(TIME+DT-OPT) 150,150,117
  117 DT=OPT-TIME
C
C     UPDATE PARAMETERS AND CONTINUE LOOP
C
  150 IF (DT .LT. 1.E-6) DT=1.E-6
      IF (ITHICK .EQ. 0) TIME = TIME + DT
      IF (ITHICK .EQ. 0) TW = TW + TDOT # DT
      QCTOT=QCTOT+QC#DT
      QRETOT=QRETOT+QRE#DT
      QNTOT=QNTOT+QN#DT
      QCCUT=QCCUT+QCCU#DT
      IT=IT+1
C
C      NEXT CALCULATION
C
      GO TO 4
  159 CALL OPTMVZ(4)
  160 CONTINUE
      IF(IOPT .NE. 0) GO TO 3405
```

```
      IF(ENVIR .GT. 0.001) GO TO 3405
C
C      TEST FOR PLOT OPTION WHILE EXECUTING PROGRAM
C      IPLTWE <= TO ZERO IMPLIES: PLOT AFTER RUN COMPLETES
C      IPLTWE > THAN     ZERO IMPLIES: PLOT WHILE EXECUTING PROGRAM
C
      IF (IPLTWE .LE. 0) GO TO 3503
C
C       CALL PLOT PROGRAM
C
C
C      CALL PLOTLO(TIME,NHFLAG,ARIDEF,ATRE,TZ,ZZ,VZ,ALFA0T,
     1 DELTAT,ITHICK,LNGPLT,ITINIT,MAXTME,DEVICE,IHCOPY)
C
3503  CONTINUE
C
C      STORE ALL DATA TO BE PLOTTED LATER
C
C     CALL STORED(TIME,NHFLAG,ARIDEF,ATRE,TZ,ZZ,VZ,ALFA0T,
     1 DELTAT,ITHICK,LNGPLT,MAXTME,ITINIT)
C
      IF(ICASE .NE. 1) GO TO 3505
      DO 3504 I=1,IT
      QC1T(I)=QC1(I)
3504  CONTINUE
3505  CONTINUE
C
C
C      NEXT CASE
C
      GO TO 3
3405  CONTINUE
      IF(IOPT.EQ.0.AND.ENVIR.GT.0.) GO TO 159
      IF (IOPT .EQ. 2) GO TO 165
C
C
C     CALL OPTIMIZATION ROUTINE TO OPTIMIZE ON SINGLE CASE.
C
C
      IF(ENVIR.GT.0.) CALL OPTMYZ(4)
      IF (ITRIED .EQ. 0) GO TO 162
      CALL OPTMYZ(3)
      IF (ICANT .EQ. 1 .AND. ITRIED .LT. 3) GO TO 162
      ITRIED = 0
      GO TO 3
  162 CALL OPTMYZ(2)
      IF(ICANT.NE.0) GO TO 180
      ITRIED = ITRIED + 1
      DEL = DELO
      GO TO 1000
  165 IF (ISAVED .GT. 0) GO TO 168
C
C
C     THIS IS THE FIRST CASE IN THE SERIES OF TWO TO BE OPTIMIZED.
C     WRITE INPUT DATA ARRAY ON SCRATCH TAPE AND SET FLAG TO 1.
C
C
      WRITE(3,DATALO)
```

```
      REWIND 3
      ISAVED = 1
      GO TO 3
  168 IF (ISAVED .GT. 1) GO TO 170
C
C
C     ISAVED FLAG = 1 INDICATES THAT THIS IS THE SECOND OF THE TWO CASES
C     TO BE OPTIMIZED.  SAVE INPUT ARRAY AND CALL OPTIMIZATION ROUTINE
C     TO COMPUTE A NEW THICKNESS. IF CONVERGENCE IS OBTAINED, REPEAT
C     CASE ONE WITH NEW MATERIAL THICKNESS.
C
      WRITE(4,DATALO)
      REWIND 4
  169 ITRIED = ITRIED + 1
      IF(ENVIR.GT.0.) CALL OPTMYZ(4)
      CALL OPTMYZ(2)
      IF (ICANT .NE. 0) GO TO 180
      READ(3,DATALO)
      REWIND 3
      WRITE(3,DATALO)
      REWIND 3
      DEL = DELO
      ISAVED = 2
      GO TO 7
  170 IF (ISAVED .GT. 2) GO TO 175
C
C
C     ISAVED FLAG = 2 INDICATES THIS WAS THE REPEAT OF CASE 1. READ
C     THE STORED DATA ARRAY OF CASE 2 AND CONTINUE THE TRAJECTORY.
C
C
      READ(4,DATALO)
      REWIND 4
      WRITE(4,DATALO)
      REWIND 4
      DEL = DELO
      ISAVED = 3
      GO TO 7
C
C
C     ISAVED = 3  INDICATES THIS WAS THE SECOND CASE OF THE TRAJECTORY
C     RE-RUN.  CALL OPTIMIZATION ROUTINE TO COMPUTE MAXIMUM OF THE
C     STORED WALL TEMPERATURES AND PRINT FINAL RESULT.
C
C
  175 CALL OPTMYZ(3)
      IF (ICANT .EQ. 1 .AND. ITRIED .LT. 3) GO TO 169
  180 ISAVED = 0
      ITRIED = 0
      IF(ENVIR.GT.0.) CALL OPTMYZ(4)
      GO TO 3
  999 CONTINUE
      CALL EXIT
      END
```

```
      SUBROUTINE AIR62 (HGM,T,RHO,P,U)
C     H=ALTITUDE
C     N=LENGTH OF TABLE(SET TO 12 FOR 1959 MODEL)
C     HB=ALTITUDE BASE
C     TMB=BASE TEMPERATURE
C     GLMB=TEMPERATURE GRADIENT
C     RHOB=BASE DENSITY
C     T=TEMPERATURE
C     RHO=DENSITY
C     P=PRESSURE
C     U=VELOCITY OF SOUND
C     G=FRAVITY
C     GIVEN H,N,HB(1)TO HB(N),TMB(1) TO TMB(N),GLMB(1) TO
C     GLMB(N),RHOB(1) TO THOB(N)
C     COMPUTE T,RHO,P,U,G
C
      DIMENSION HB(22),TMB(22),GLMB(22),RHOB(22)
C     DIMENSION HB(22),TMB(22),GLMB(22),RHOB(22)
      DATA (HB(I),I=1,22)/0.,36089.24,65616.8,104985.88,154199.48,
     2170603.68,200131.24,259186.36,291153.22,323002.64,354753.29,
     2386406.18,480780.86,512045.95,543215.24,605268.39,728243.79,
     3939894.72,1234645.71,1520799.26,1798726.44,2068776.31/
      DATA (TMB(I),I=1,22)/518.67,2*389.97,411.57,2*487.17,454.77,
     12*325.17,374.17,469.17,649.17,1729.17,1999.17,2179.17,2431.17,
     22791.17,3295.17,3889.17,4357.17,4663.17,4861.17/
      DATA (GLMB(I),I=1,22)/-3.5662E-3,0.,5.4864E-4,1.5362E-3,0.,-1.0973
     1E-3,-2.1946E-3,0.,1.6953E-3,2.8343E-3,5.6867E-3,1.1444E-2,8.635E-3
     2,5.7744E-3,4.061E-3,2.927E-3,2.3811E-3,2.0152E-3,1.6355E-3,1.1011E
     3-3,7.3298E-4,0./
      DATA (RHOB(I),I=1,22)/2.3769E-3,7.0612E-4,1.7082E-4,2.5661E-5,
     12.7698E-6,1.4735E-6,4.8719E-7,3.8826E-8,6.1508E-9,9.6511E-10,
     21.9071E-10,4.7266E-11,3.5624E-12,2.2488E-12,1.5592E-12,8.4345E-13,
     33.0346E-13,6.956E-14,1.2608E-14,3.0599E-15,9.0031E-16,3.0463E-16/
      DATA N/22/,GO/32.1740485/,RE/20898908./
   12 H=(RE*HGM)/(RE+HGM)
      G=GO*((RE/(RE+HGM))**2)
      DO 1 I=2,N
      IF(H-HB(I))2,1,1
    1 CONTINUE
      GO TO 5
    2 IF(GLMB(I-1))3,4,3
    4 RHO=RHOB(I-1)*EXP(-(H-HB(I-1))*GO/(1716.4827*TMB(I-1)))
      T=TMB(I-1)
      GO TO 6
    3 T=TMB(I-1)+GLMB(I-1)*(H-HB(I-1))
      RHO=RHOB(I-1)*EXP(-(1.0+GO/(1716.4827* GLMB(I-1)))*ALOG(T/TMB(I-1)
     1))
      GO TO 6
    5 T=TMB(N)
      RHO=RHOB(N)*EXP(-(H-HB(N))*GO/(1716.4827*TMB(N)))
      WRITE(6,1000) H,HGM
 1000 FORMAT (2E14.5)
    6 U=SQRT(1.4*(1716.4827*T))
      P=RHO*(1716.4827*T)
      RETURN
      END
```

```
      SUBROUTINE ATMS4 (H,T,DENS,P,SPS)
      REAL LMB
      DIMENSION PB(14),ZI(19),PK(6,5),RHOK(6,3),TK(6,5),TMB(          ATMS4
     114),LMB(14),TB(14)
      DATA PBASE /6.231001759E-5/                                     ATMS4
      DATA ZI           /10832.1,17853.3,28000.,49000.,83004         ATMS4
     X.,9.E4,1.E5,1.1E5,1.2E5,1.5E5,1.6E5,1.7E5,1.9E5,2.3E5,          ATMS4
     X3.E5,4.E5,5.E5,6.E5,7.E5/                                       ATMS4
      DATA   PK                      /1.6871582E-2,                  ATMS4
     X-1.1425176E-4,-1.3612327E-9,7.3624145E-14,                      ATMS4
     X-1.0800315E-17,3.3046432E-22,-7.9910777E-2,                     ATMS4
     X-8.1046438E-5,-5.5522383E-9,3.1116969E-13,                      ATMS4
     X-1.6687827E-17,3.8319351E-22,9.8414277E-1,                      ATMS4
     X-2.6976917E-4,8.5227541E-9,-3.9620263E-13,                      ATMS4
     X1.0146471E-17,-1.0264318E-22,1.14118495E1,                      ATMS4
     X-4.11497477E-4,1.33664855E-8,-3.59518975E-13,                   ATMS4
     X5.10097254E-18,-2.89055894E-23,9.99324461,                      ATMS4
     X-2.58298177E-4,3.76139346E-9,-4.20887236E-14,                   ATMS4
     X1.60182148E-19,-1.92508927E-25/                                 ATMS4
      DATA   RHOK                     /1.3302117E-2,                  ATMS4
     X-8.8502064E-5,-4.2143056E-9,5.9517557E-13,                      ATMS4
     X-3.9744789E-17,7.8771273E-22,1.2667122E-1,                      ATMS4
     X-1.3373147E-4,2.0667371E-9,2.3396109E-13,                       ATMS4
     X-3.2562503E-17,7.9035209E-22,9.2751266E-1,                      ATMS4
     X-1.4349679E-4,-2.8271736E-9,4.7480092E-14,                      ATMS4
     X1.8863246E-18,-4.2702411E-23/                                   ATMS4
      DATA   TK                      /2.9667877E2,-6.7731001E-3,     ATMS4
     X8.4619805E-7,-1.7004049E-10,1.145145E-14,                       ATMS4
     X-2.4898788E-19,2.6892151E2,4.3075352E-3,                        ATMS4
     X-8.9159672E-7,-2.8929791E-11,5.0724856E-15,                     ATMS4
     X-1.1490372E-19,3.7064557E2,-3.2858965E-2,2.0645636E-6,          ATMS4
     X-4.3283944E-11,-5.7507242E-17,8.2924583E-21,                    ATMS4
     X2.044798E1,2.07698384E-2,-8.63038789E-7,                        ATMS4
     X1.66392417E-11,-9.30076185E-17,-4.09005108E-22,                 ATMS4
     X-4.98865953E2,3.92137281E-2,-4.95180601E-7,                     ATMS4
     X-3.26219854E-12, 9.66650364E-17,-4.78844279E-22/                ATMS4
      DATA   TMB              / 180.65,210.65,260.65,360.65,          ATMS4
     X960.65,1110.65,1210.65,1350.65,1550.65,1830.65,                 ATMS4
     X2160.65,2420.65,2590.65,2700.65/                                ATMS4
      DATA   LMB             / 3.E-3,5.E-3,10.E-3,20.E-3,15.E-3,      ATMS4
     X10.E-3,7.E-3,5.E-3,4.E-3,3.3E-3,2.6E-3,1.7E-3,1.1E-3,           ATMS4
     X1.1E-3/                                                         ATMS4
      DATA   PB             /.172244361E-4,.315971712E-5,            ATMS4
     X.774389807E-6,.265977111E-6,.535849383E-7,                      ATMS4
     X.391284945E-7,.295911117E-7,.178715656E-7,                      ATMS4
     X.739258171E-8,.200573116E-8,.430456606E-9,                      ATMS4
     X.117315480E-9,.370198961E-10,.128115330E-10/                    ATMS4
      Z=H/3.280833                                                    ATMS4
      IF (Z) 5,9,6                                                    ATMS4
C H LESS THAN 0 SET TO 0                                              ATMS4
    5 Z=0.0                                                           ATMS4
      GO TO 9
    6 IF (Z-700000.) 9,9,8                                            ATMS4
C  H GREATER THAN 700000 METERS SET TO 700000                         ATMS4
    8 Z=700000.                                                       ATMS4
    9 N=0                                                             ATMS4
   10 N=N+1                                                           ATMS4
      IF (Z-ZI(N)) 40,40,10                                           ATMS4
   40 IF (N-5)20,20,65
   20 Z2=Z*Z                                                          ATMS4
      Z3=Z2*Z                                                         ATMS4
      Z4=Z2*Z2                                                        ATMS4
      Z5=Z3*Z2                                                        ATMS4
C  STD COMPUTATION FOR TEMPERATURE                                    ATMS4
   65 IF (N-5) 70,70,80
C  H LESS THAN 83004. METERS                                          ATMS4
   70 T= TK(1,N)+TK(2,N)*Z+TK(3,N)*Z2+TK(4,N)*Z3+TK(5,N)*Z4+          ATMS4
     1TK(6,N)*Z5                                                      ATMS4
      T =T*1.8                                                        ATMS4
      GO TO 110                                                       ATMS4
   80 IF (N-6) 85,82,85                                               ATMS4
C T FOR  83004. THRU 90000.                                           ATMS4
   82 T=180.65*1.8                                                    ATMS4
      GO TO 110                                                       ATMS4
C T FOR GREATER THAN 90000                                            ATMS4
   85 M=N-6                                                           ATMS4
      T=TMB(M)+LMB(M)*(Z-ZI(N-1))                                     ATMS4
      T =T*1.8                                                        ATMS4
```

```
      110 IF (N-5) 130,130,150
C H LESS THAN 83004 METERS                                                    ATMS4
      130 CON= 10.0                                                           ATMS4
          IF (N-3) 135,135,132                                                ATMS4
      132 CON=9.80665E-4                                                      ATMS4
      135 P =CON *EXP(PK(1,N)+PK(2,N)*Z+PK(3,N)*Z2+PK(4,N)*Z3+                ATMS4
         1PK(5,N)*Z4+PK(6,N)*Z5)                                              ATMS4
          P =P*208.9                                                          ATMS4
          GO TO 300                                                           ATMS4
      150 IF (N-6)160,160,170                                                 ATMS4
      160 P=PBASE*EXP((-1.373301523E12*(Z-83004.))/(180.65*                   ATMS4
         1(6344860.+Z)*(6344860.+83004.)))                                    ATMS4
          P =P*208.9                                                          ATMS4
          GO TO 300                                                           ATMS4
      170 M=N-6                                                               ATMS4
          P=EXP(ALOG(PB(M))+(1.373301523E12/(LMB(M)*(6344860.+Z)*             ATMS4
         1(6344860.+ZI(N-1))))*ALOG(TMB(M)/(TMB(M)+(LMB(M)*(Z-ZI(N-1))))))    ATMS4
          P =P*208.9                                                          ATMS4
      300 IF (N-3) 316,316,320
      316 DENS=(1.16790729)*EXP(RHOK(1,N)+RHOK(2,N)*Z+RHOK(3,N)*              ATMS4
         1Z2+RHOK(4,N)*Z3+RHOK(5,N)*Z4+RHOK(6,N)*Z5)                          ATMS4
          DENS =DENS*.00194                                                   ATMS4
          GO TO 360
      320 DENS=5.825871E-4*P/T
      360 SPS=49.021177*SQRT(T)
          RETURN                                                              ATMS4
          END                                                                 ATMS4
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
      SUBROUTINE BINTRP(X,Y,ITABLE,ZZ)
C
C*************************************************************************
C
C THIS SUBROUTINE COMPUTES PRANDTL NO.,LEWIS NO.,AND HSUBD
C
C*************************************************************************
C
      COMMON/ERRFLG/NERROR
      COMMON/FFNUM/HSUBD,ALEW
      DIMENSION XJ(100),YI(26), Z(26,40), A(1040), ZI(40,26)
      EQUIVALENCE (A,ZI)
      IF(IFLAG.EQ.1) GO TO 9
      DO 1 J=1,40
      DO 1 I=1,26
    1 Z(I,J)=ZI(J,I)
    9 IF(ITABLE.EQ.1) GO TO 10
      IF(ITABLE.EQ.2)GO TO 20
      IF(Y.LT.1.E-6) Y=1.E-6
      M=66                                                          BINT0015
      MM=90                                                         BINT0020
      N=19                                                          BINT0025
      NN=26                                                         BINT0030
      IF( (Y .LT. YI(N)) .OR. (X .LT. XJ(M) )) GO TO 300            BINT0035
      MN=65                                                         BINT0040
      GO TO 30                                                      BINT0045
   10 M=1                                                           BINT0050
      IF(Y.LT.1.E-8) Y=1.E-8
      MM=40                                                         BINT0055
      N=1                                                           BINT0060
      NN=10                                                         BINT0065
      IF( (Y .LT. YI(N) ) .OR. (X .LT. XJ(M) )) GO TO 310           BINT0070
      MN=0                                                          BINT0075
      GO TO 30                                                      BINT0080
   20 M=41                                                          BINT0085
      MM=65                                                         BINT0090
      N=11                                                          BINT0095
      NN=18                                                         BINT0100
      IF( (Y .LT. YI(N) ).OR. (X .LT. XJ(M)) ) GO TO 310            BINT0105
      MN=40                                                         BINT0110
   30 M=M+1                                                         BINT0115
      DO 40  I=N,NN                                                 BINT0120
      IF( Y.LT. YI(I)) GO TO 50
   40 CONTINUE
      I=NN                                                          BINT0130
   50 M=M+1                                                         BINT0135
      DO 60 J=M,MM                                                  BINT0140
      IF( X .LT. XJ(J) ) GO TO 70
   60 CONTINUE
      K=MM-MN                                                       BINT0150
      GO TO 80                                                      BINT0155
   70 K=J-MN                                                        BINT0160
   80 ZMIN= Z(I-1,K-1)+((X-XJ(J-1))/(XJ(J)-XJ(J-1)))*(Z(I-1,K)-Z(I-1,K-1BINT0165
     1))                                                            BINT0170
      ZMAX=Z(I,K-1)+((X-XJ(J-1))/(XJ(J)-XJ(J-1)))*(Z(I,K)-Z(I,K-1))  BINT0175
      ZZ=ZMIN+((Y-YI(I-1))/(YI(I)-YI(I-1)))*(ZMAX-ZMIN)              BINT0180
      IF((ITABLE.EQ.1).AND.(ZZ.LT. 0.))ZZ=0.
      IF((ITABLE.EQ.2).AND.(ZZ.LT..5))ZZ=.5
      IF((ITABLE.EQ.1).AND.(ZZ.GT.12.45E+3))ZZ=12.45E+3
      IF((ITABLE.EQ.3).AND.(ZZ.LT..678))ZZ=.678
      IF((ITABLE.EQ.3).AND.(X.GE. 24000.).AND.(ZZ.GT..734))ZZ=.734
      IFLAG=1
      IF (ITABLE .EQ. 1) HSUBD=ZZ
      IF (ITABLE .EQ. 2) ALEW=ZZ
      RETURN                                                        BINT0185
  300 WRITE(6,900) X,Y                                              BINT0190
  900 FORMAT(72H0 *****  NEGATIVE TEMP OR PRESS RATIO LESS THAN 10-6 IN SBINT0195
     1UBR. BINTRP.  T=,E12.6,6H P/P0=,E12.6)
      NERROR=1
      RETURN
  310 WRITE(6,910) X,Y                                              BINT0210
  910 FORMAT(73H0 *****  NEGATIVE TEMP OR DENSITY RATIO LESS THAN 10-8 INBINT0215
     1SUBR. BINTRP.  T=,E12.6,15H DENSITY RATIO=,E12.6)             BINT0220
      NERROR=1
      RETURN
```

```
76:      DATA (XJ(J),J=1,90)/0.,5400.,5760.,6120.,6480.,6840.,7200.,7560., BINT0230
77:     17920.,8280.,8640.,9000.,9360.,9720.,10080.,10440.,10800.,11160.,11BINT0235
78:     2520.,11880.,12240.,12600.,12960.,13320.,13680.,14040.,14400.,14760BINT0240
79:     3.,15120.,15480.,15840.,16200.,16560.,16920.,17280.,17640.,18000., BINT0245
80:     419800.,23400.,36000.,0.,3600.,4500.,5400.,6300.,7200.,8100.,9000.,BINT0250
81:     59900.,10800.,11700.,12600.,13500.,14400.,15300.,16200.,17100.,1800BINT0255
82:     60.,18900.,19800.,20700.,21600.,22500.,23400.,25200.,   0.0 ,3600.,BINT0260
83:     7 4500.,                                                          BINT0265
84:     8   5400.,6300.,7200.,8100.,9000.,9900.,10800.,11700.,12600.,13500.BINT0270
85:     9,  14400.,15300.,16200.,17100.,18000.,18900.,19800.,20700.,21600.,BINT0275
86:     122500.,23400.,25200./                                            BINT0280
87:      DATA (YI(I),I=1,26)/.958E-8, .958E-6, .958E-5 , .958E-4 , .958E-3 BINT0285
88:     1 ,.958E-2 , .958E -1 ,.958  , 9.58,   19.16  ,1.E-6,1.E-4,1.E-3,1.BINT0290
89:     2E-2,  1.E-1 , 1. ,  10., 100. , 1.E-6  , 1.E-4 , 1.E-3 , 1.E-2, 1.BINT0295
90:     3E-1 , 1.  , 10. , 100. /                                         BINT0300
91:      DATA (A(K),K=1,200) / 0.,   1.8E+3, 3.82E+3,     6.0E+3,
92:     1 8.2E+3 , 10.6E+3  , 11.43E+3 , 12.0E+3  , 12.23E+3  , 12.26E+3 , BINT0310
93:     2  30*12.45E+3  , 0. ,  1.56E+3 , 1.621E+3 , 1.779E+3  , 2.138E+3 ,BINT0315
94:     3 2.857E+3 , 4.122E+3 , 5.98E+3 , 8.18E+3 , 10.11E+3  , 11.35E+3 , BINT0320
95:     4 11.96E+3 , 12.23E+3  , 12.35E+3  , 12.40 E+3 , 12.43E+3 , 12.44E+BINT0325
96:     53 , 23*12.45E+3 ,  0. , 1.522E+3  , 1.553E+3 , 1.607E+3, 1.727E+3,BINT0330
97:     61.97E+3 , 2.432E+3, 3.219E+3 , 4.422E+3 , 6.037E+3  ,7.869E+3 ,9.5BINT0335
98:     762E+3,  10.83E+3, 11.6E+3 ,12.01E+3 , 12.22E+3 , 12.33E+3 , 12.38EBINT0340
99:     8+3 , 12.42E+3 , 12.43E+3 , 12.44E+3 ,19*12.45E+3 ,  0. ,1.411E+3, BINT0345
100:    91.489E+3 , 1.531E+3 , 1.579E+3, 1.664E+3 , 1.819E+3, 2.092E+3 ,2.5BINT0350
101:    143E+3 , 3.235E+3 , 4.215E+3, 5.480E+3  , 6.945E+3 ,  8.432E+3 , 9.BINT0355
102:    2745E+3 , 10.748E+3 , 11.428E+3 , 11.85E+3 , 12.09E+3  , 12.23E+3 ,BINT0360
103:    3 12.32E+3  , 12.37E+3  , 12.40E+3 , 12.41E+3 , 12.42E+3 , 4*12.44EBINT0365
104:    4+3 , 11*12.45E+3 , 0., 1.002E+3 , 1.256E+3 , 1.397E+3 , 1.472E+3, BINT0370
105:    5 1.490E+3 , 1.593E+3 , 1.690E+3 , 1.847E+3 , 2.091E+3 , 2.458E+3, BINT0375
106:    6 2.979E+3 , 3.683E+3 , 4.580E+3 , 5.649E+3 ,  6.831E+3 , 8.039E+3,BINT0380
107:    7 9.145E+3 ,  10.094E+3 , 10.82E+3, 11.36E+3 , 11.72E+3, 11.96E+3, BINT0385
108:    8 12.12E+3 , 12.22E+3 , 12.30E+3 , 12.34E+3 , 12.36E+3, 12.39E+3 , BINT0390
109:    9 12.40E+3 , 12.42E+3,12.43E+3 , 3*12.44E+3 , 5*12.45E+3/          BINT0395
110:     DATA (A(K),K=201,280)/ 0., .461E+3, .7198E+3,
111:    1 .9597E+3,   1.184E+3, 1.322E+3,  1.414E+3,  1.488E+3,  1.563E+3, BINT0405
112:    2 1.658E+3,  1.791E+3 , 1.978E+3, 2.236E+3 , 2.585E+3 ,  3.041E+3 ,BINT0410
113:    3 3.611E+3,  4.304E+3 , 5.102E+3, 5.989E+3 , 6.922E+3 ,   7.86E+3 ,BINT0415
114:    4 8.754E+3,  9.550E+3 , 10.23E+3, 10.78E+3 , 11.21E+3 , 11.53E+3  ,BINT0420
115:    5 11.76E+3,  11.95E+3 , 12.08E+3, 12.18E+3 , 12.24E+3 , 12.29E+3  ,BINT0425
116:    6 12.33E+3,  12.35E+3 , 12.38E+3, 12.39E+3 ,3*12.45E+3,   0.      ,BINT0430
117:    7 1.660E+2, 2.869E+2  , 4.483E+2, 6.378E+2 , 8.324E+2 , 1.009E+3  ,BINT0435
118:    81.1154E+3, 1.269E+3  , 1.364E+3, 1.452E+3 , 1.543E+3 , 1.650E+3  ,BINT0440
119:    9 1.784E+3, 1.954E+3  , 2.169E+3, 2.437E+3 , 2.769E+3 , 3.168E+3  ,
120:    1 3.636E+3, 4.176E+3  , 4.772E+3, 5.431E+3 , 6.125E+3 , 6.840E+3  ,BINT0450
121:    2 7.554E+3, 8.238E+3  , 8.902E+3, 9.483E+3 , 10.01E+3 , 10.45E+3  ,BINT0455
122:    3 10.83E+3, 11.14E+3  , 11.40E+3, 11.60E+3 , 11.77E+3 , 11.90E+3  ,BINT0460
123:    43*12.45E+3/                                                      BINT0465
124:     DATA (A(K),K=281,360)/ 0.,  5.466E+1,  9.779E+1,
125:    1 1.611E+2, 2.467E+2  , 3.537E+2, 4.777E+2 , 6.118E+2 , 7.475E+2  ,BINT0475
126:    2 8.783E+2, 9.973E+2  , 1.106E+3, 1.207E+3 , 1.303E+3 , 1.401E+3  ,BINT0480
127:    3 1.505E+3, 1.622E+3  , 1.756E+3, 1.914E+3 , 2.097E+3 , 2.314E+3  ,BINT0485
128:    4 2.565E+3, 2.849E+3  , 3.174E+3, 3.538E+3 , 3.937E+3 , 4.373E+3  ,BINT0490
129:    5 4.840E+3, 5.341E+3  , 5.842E+3, 6.365E+3 , 6.890E+3 , 7.417E+3  ,BINT0495
130:    6 7.922E+3, 8.397E+3  , 8.872E+3, 9.286E+3 , 11.60E+3 ,2*12.45E+3 ,BINT0500
131:    7  0.     , 17.30     , 31.65   , 53.20    , 83.2     ,1.236E+2   ,BINT0505
132:    8 1.743E+2, 2.359E+2  , 3.069E+2, 3.85E+2  , 4.71E+2  , 5.59E+2   ,BINT0510
133:    9 6.28E+2 , 7.089E+2  , 8.291E+2, 9.182E+2 , 1.007E+3 , 1.096E+3  ,BINT0515
134:    1 1.189E+3, 1.285E+3  , 1.388E+3, 1.501E+3 , 1.624E+3 , 1.760E+3  ,BINT0520
135:    2 1.910E+3, 2.076E+3  , 2.259E+3, 2.459E+3 , 2.680E+3 , 2.921E+3  ,BINT0525
136:    3 3.179E+3, 3.46E+3   , 3.752E+3, 4.061E+3 , 4.387E+3 , 4.732E+3  ,BINT0530
137:    4 5.08E+3 , 6.80E+3   , 10.5E+3 , 12.45E+3/                       BINT0535
138:     DATA (A(K),K=361,640)/ 0., 13.88, 22.48,
139:    1  37.72  ,  59.42    ,  88.47   , 1.257E+2 , 1.713E+2 , 2.252E+2 ,BINT0545
140:    2 2.865E+2, 3.482E+2  , 4.267E+2 , 5.026E+2 , 5.817E2  , 6.612E+2 ,BINT0550
141:    3 7.414E+2, 8.227E+2  , 9.031E+2 , 9.879E+2 , 1.074E+3 , 1.164E+3 ,BINT0555
142:    4 1.260E+3, 1.360E+3  , 1.470E+3 , 1.590E+3 , 1.720E+3 , 1.863E+3 ,BINT0560
143:    5 2.016E+3, 2.187E+3  , 2.372E+3 , 2.568E+3 , 2.784E+3 , 3.01E+3  ,BINT0565
144:    6 3.255E+3, 3.513E+3  , 3.785E+3 , 4.07E+3  , 5.6E+3   , 10.5E+3  ,BINT0570
145:    7 12.45E+3,  2*1.35   , 1.125, 1.09 , .93  ,  .73 ,  .62 ,  .56 ,   BINT0575
146:    8  .52 ,  .500,30*.50, 1.35 , 1.335, 1.172, 1.147, 1.143, 1.051,   BINT0580
147:    9  .786,  .609,  .580,  .540,  .520,  .505,28*.50, 1.35 , 1.346,   BINT0585
148:    1 1.233, 1.157, 1.154, 1.130,  .998,  .750,  .610,  .578,  .541,   BINT0590
149:    2  .521,  .509,27*.50, 1.35 , 1.355, 1.355, 1.213, 1.167, 1.144,   BINT0595
150:    3 1.114,  .970,  .762,  .628,  .588,  .574,  .535,  .519,  .509,   BINT0600
151:    425*.50, 1.35 , 1.355, 1.391, 1.327, 1.227, 1.180, 1.160, 1.105,   BINT0605
152:    5  .982,  .808, .669 , .605 , .587 , .570 , .530 , .518 , .507 ,   BINT0610
153:    623*.50,2*1.35,1.404 , 1.405, 1.320, 1.225, 1.196, 1.158, 1.115,   BINT0615
```

```
     71.019 , .885 , .746 , .652 , .601 , .570 ,  .567,  .530, .515 ,
     8 .507 ,  .502,20*.50/
      DATA (A(K),K=641,1000)/ 1.35,1.35, 1.407, 1.437, 1.424,
     1 1.347, 1.265, 1.215, 1.167, 1.131, 1.071, .975 , .860 , .756 ,
     2  .669, .618 , .584 , .558 , .540 , .520 ,  .510, .502 , 18*.5,
     32*1.35,1.408 ,1.445 , 1.464, 1.449, 1.404, 1.327, 1.268, 1.235,
     4 1.158, 1.118, 1.059, .979 , .893 , .805 , .726 , .662 , .618 ,
     5 .585 , .564 , .531 , .525 , .518 ,16*.50,  .77 , .772 , .732 ,
     6 .726 , .710 , .681 , .680 , .690 , .700 , .710 , .718 ,  .725,
     7 .731 ,27*.734, .77 , .772 , .750 , .735 , .734 , .717 , .683 ,
     8 .683 , .694 , .702 , .712 , .720 , .726 , .730 ,26*.734,.77  ,
     9 .772 ,.763  , .739 , .734 , .729 , .708 , .682 ,.686  , .697 ,
     1 .704 , .712 , .719 , .729 ,26*.734, .77 , .772 , .770 , .747 ,
     2 .738 , .734 , .725 , .704 ,.684  , .691 ,.7,.708,.716,.725,
     3       26*.734, .77 , .773 , .773 , .762 , .744 , .738 , .732 ,
     4 .723 , .705 , .687 , .689 , .703 , .710 , .721 , .729 ,25*.734,
     5 .77  , .772 ,  .774, .773 , .756 , .743 , .739 , .732 , .724 ,
     6 .709 , .693 , .684 , .696 , .710 ,.72,.727,24*.734,.77,.772,
     7 .775 , .777 , .772 , .758 , .747 , .739 , .732 , .724 , .715 ,
     8 .700 , .690 ,  .690, .693 , .707 , .714 , .725 ,22*.734/
      DATA (A(K),K=1001,1040)/ .77, .772, .775, .775, .776, .771,
     1 .764, .753 , .744 , .740 , .728 , .720 , .711 , .698 , .691 ,
     2 .687 ,  .687,  .695 , .704 , .710 , .716 , .722 , .727, .732,
     316*.734/
      END
```

```
      SUBROUTINE CHEEVY(NSTEP)
      DIMENSION ALPHA(25), S(25), DTEMP(100),G(25),ZPLUS(25),ZMINUS(25),
     1A(25), B(25), C(25), D(25)
      DIMENSION TSAVE(25),RHO(25),CP(25),COND(25),ZZ(50)
      COMMON/FLWFLD/ PHIL(16),TW,HW,REST(34)
      COMMON/ THICK/  DTEQ, TDOT, TEQ, QC, QR, HCOUT, EMISS, HREC,
     1 DT,CTIME, PL, DTO, DTI, TEQ2
      COMMON/HANDY/IMAX,DX(25),T(25),MPFLAG(25), NTIWZ,TSYNK,EMISIN,HCIW
     1,TGSF,TIWZ(50),HCIWZ(50),TGASZ(50),TSINKZ(50),TWI,TSINK,TGAS,HCIN,
     2 IFIRST,DELT
2000  FORMAT(1H0, 13X,  36H***NEWTON-RAPHSON FAILED TO CONVERGE,
     1       45H ON A VALUE FOR THE OUTER WALL TEMPERATURE AT, F10.3,
     2       11H SECONDS***)
2001  FORMAT(/1H ,5HK(1)=, E10.3,8H  DX(1)=,E9.3, 2X, 4HEPS=, E11.3, 2X,
     1 6HNSUBC=, E9.3, 2X, 5HTREC=, E9.3, 2X, 6HHWALL=, E9.3, /1H ,
     25HTREC=, E10.3, 2X, 6HTWALL=, E9.3, 2X, 5HSTEP=, I2)
3000  FORMAT(1H0, 13X, 36H***NEWTON-RAPHSON FAILED TO CONVERGE,
     1       45H ON A VALUE FOR THE INNER WALL TEMPERATURE AT, F10.3,
     2       11H SECONDS***)
3001  FORMAT (1H ,8HK(IMAX)=, E9.3, 2X, 9HDX(IMAX)=, E9.3, 2X, 6HEPSIN=,
     1 E9.3, 2X, 3HHC=, E10.3, 2X, 6HTSINK=, E9.3, 2X, 5HTGAS=, E10.3, 2
     2X, 5HSTEP=, I2)
4000  FORMAT (/1H ,20X, 17HLAST TEMPERATURES/(10X, 5E20.5/))
      COMMON/ERRFLG/NERROR
      COMMON/FLAG/ IDEAL
      DATA STEVIE/ .4760E-12/
C
C
C     SET INITIAL CONDITIONS.
C
C
      IF (IFIRST .EQ. 0) GO TO 150
      DT = DELT
  150 IF (NSTEP .NE. 1) GO TO 300
      TWOLD = TW
      DO 175  I = 1, IMAX
  175 TSAVE(I)=T(I)
      CALL STOCK(IMAX,MPFLAG,T,RHO,CP,COND)
      IF(IDEAL.GT.0) GO TO 176
      CALL MOLIER(HW, PL, 2, TW, ZZ, SS, RR, GR)
      IF(IDEAL.GT.0) GO TO 176
      CALL MOLIER(HREC, PL, 0, TREC, ZZ, SS, RR, GR)
      IF(IDEAL.GT.0) GO TO 176
      GO TO 180
  176 HW=.24*TW
      TREC=HREC/.24
  180 HCIN=HCIW
      TGAS=TGSF+459.7
      TSINK=TSYNK+459.7
      IF(NTIWZ.LE.0) GO TO 903
      IF(HCIWZ(1).LE.0.) GO TO 901
      CALL TBLIN(CTIME,TIWZ,HCIN,HCIWZ,Z,ZZ,NTIWZ)
  901 IF(ABS(TGASZ(1)).LE..0001) GO TO 902
      CALL TBLIN(CTIME,TIWZ,TG,TGASZ,Z,ZZ, NTIWZ)
      TGAS=TG+459.7
  902 IF(ABS(TSINKZ(1)).LE..0001) GO TO 903
      CALL TBLIN(CTIME,TIWZ,TS,TSINKZ,Z,ZZ,NTIWZ)
      TSINK=TS+459.7
  903 CONTINUE
      QC = HCOUT * (HREC - HW)
      QR =  EMISS * STEVIE * TW**4
      QO = -QR + QC
      QI = EMISIN * STEVIE * TWI**4 - HCIN * (TGAS - TWI) - EMISIN *
     1 STEVIE * TSINK**4
C
C
C     STEP ONE OF RUNGE-KUTTA INTEGRATION. COMPUTE OUTER AND INNER WALL
C     HEAT FLUXES USING INITIAL TEMPERATURES AT TIME(1) OR RESULTS OF
C     LAST SERIES OF CALCULATIONS AT TIME(N).
C
C
  300 CONTINUE
C
C
C     COMPUTE COEFFICIENTS OF TRI-DIAGONAL MATRIX OF INTERIOR
C     TEMPERATURES AT TIME(N+1/2) USING RESULTS OF PREVIOUS CALCULATIONS
C
C
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      G(1) = RHO(1) * CP(1) * DX(1)
      GOUT = G(1)
      ZPLUS(1) = 2.*COND(1)*COND(2)/(COND(2)*DX(1) + COND(1)*DX(2))
      ZMINUS(1)= 0.
      FOUT = ZPLUS(1)/G(1)
      A(1) = 0.
      B(1) = 1. + FOUT * (DT/2.)
      C(1) = -FOUT * (DT/2.)
      D(1) = TSAVE(1) + QO / GOUT * DT/2.
      IMINUS = IMAX - 1
      IF(IMAX.EQ.2) GO TO 401
      DO 400  I = 2, IMINUS
      ZMINUS(I) = 2. * COND(I)*COND(I-1) / (COND(I-1)*DX(I) + COND(I)*
     1 DX(I-1))
      ZPLUS(I) = 2. * COND(I)*COND(I+1) / (COND(I+1)*DX(I) + COND(I)*
     1 DX(I+1))
      G(I) = RHO(I) * CP(I) * DX(I)
      A(I) = - (DT/2.) * ZMINUS(I)/G(I)
      B(I) = 1. + (DT/2.) * (ZPLUS(I) + ZMINUS(I))/ G(I)
      C(I) = -(DT/2.)  * ZPLUS(I)/G(I)
      D(I) = TSAVE(I)
  400 CONTINUE
  401 ZMINUS(IMAX) = 2. * COND(IMAX)*COND(IMAX-1) / (COND(IMAX-1)*DX(IMA
     1X) + COND(IMAX)*DX(IMAX-1))
      ZPLUS(IMAX) = 0.
      G(IMAX) = RHO(IMAX) * CP(IMAX) * DX(IMAX)
      GIN = G(IMAX)
      FIN = ZMINUS(IMAX) / G(IMAX)
      A(IMAX) = -FIN * (DT/2.)
      B(IMAX) = 1. + FIN * (DT/2.)
      C(IMAX) =  0.
      D(IMAX) = TSAVE(IMAX) - DT/2. * QI/GIN
C
C
C     SOLVE FOR NEW TEMPERATURES BY GAUSSIAN ELIMINATION METHOD.
C
C
      CALL GAUSS(A, B, C, D, ALPHA, S, T, IMAX)
C
C
C     COMPUTE THE DERIVATIVES ASSOCIATED WITH NEW TEMPERATURES.
C
C
      CALL DRIVEL(DTEMP, G, ZPLUS, ZMINUS, QO, QI, T, NSTEP, IMAX)
C
C
C     AT STEPS 1,2, AND 3 OF RUNGE-KUTTA, USE LATEST TEMPERATURES TO
C     COMPUTE NEW OUTER WALL TEMPERATURE.
C
C
C     IF NSTEP = 4, RUNGE-KUTTA IS COMPLETED. CALCULATE FINAL NODE
C     TEMPERATURES, WALL TEMPERATURES, AND HEAT FLUXES
C
C
      IF(NSTEP .EQ. 4) CALL FINALT(TSAVE, DTEMP, IMAX, 4, DT, T)
      TNEWT1 = T(1)
      LIN = 2 * IMAX + 1
C
C
C     AT STEP 4, USE TEMPERATURE(N) PLUS DERIVATIVE COMPUTED AT STEP 3.
C
C
      IF (NSTEP .EQ. 3) TNEWT1 = TSAVE(1) + DTEMP(LIN) * DT
      TERM = 2. * COND(1)/ DX(1)
      AOUT = EMISS * STEVIE
      HCOUTI = HCOUT * (HREC-HW)/(TREC-TW)
      BOUT = HCOUTI + TERM
      COUT = HCOUTI * TREC + TERM * TNEWT1
C
C
C     SOLVE FOR NEW OUTER WALL TEMPERATURE BY NEWTON-RAPHSON METHOD.
C
C
      CALL NEWT(AOUT, BOUT, COUT, TW, ICANT)
C
C
C     IF CONVERGENCE NOT OBTAINED, ABANDON CASE.
C
C
```

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158:       IF (ICANT .NE. 0) GO TO 900
159:C
160:C
161:C      REPEAT PROCESS TO COMPUTE NEW INNER WALL TEMPERATURE.
162:C
163:C
164:       TNEWT2 = T(IMAX)
165:       LIN = 3 * IMAX
166:       IF (NSTEP .EQ. 3) TNEWT2 = TSAVE(IMAX) + DTEMP(LIN) * DT
167:       TERM2 = 2. * COND(IMAX)/ DX(IMAX)
168:       AIN =-EMISIN * STEVIE
169:       BIN =- (HCIN    + TERM2)
170:       CIN = AIN * TSINK**4 - HCIN*TGAS - TERM2*TNEWT2
171:       CALL NEWT(AIN, BIN, CIN, TWI, ICANT)
172:       IF (ICANT .NE. 0) GO TO 910
173:C
174:C      CORRECT HEAT FLUXES FOR NEW WALL TEMPERATURES
175:C
176:       IF (IDEAL .GT. 0) GO TO 410
177:       CALL MOLIER (HW,PL,2,TW,ZZ,SS,RR,GR)
178:       IF (IDEAL .GT. 0) GO TO 410
179:       GO TO 420
180:  410 HW = .24 * TW
181:  420 CONTINUE
182:       QC = HCOUT * (HREC - HW)
183:       QR =  EMISS * STEVIE * TW**4
184:       QO = -QR + QC
185:       QI = EMISIN * STEVIE * TWI**4 - HCIN * (TGAS - TWI) - EMISIN *
186:      1 STEVIE * TSINK**4
187:  500 TDOT =(TW - TWOLD)/DT
188:C
189:C
190:C      COMPUTE MAXIMUM STABLE TIME AS FUNCTION OF THE INNER AND WALL
191:C      EQUILIBRIUM TEMPERATURES.
192:C
193:C
194:       IF (NSTEP .EQ. 4) CALL STABLE(FIN, FOUT, GIN, GOUT, QI, TREC)
195:       IF(NERROR.EQ.1) RETURN
196:       IF (IFIRST .NE. 1) GO TO 450
197:       CALL STABLE (FIN, FOUT, GIN, GOUT, QI, TREC)
198:       IF(NERROR.EQ.1) RETURN
199:       DO 425 I = 1, IMAX
200:  425 T(I) = TSAVE(I)
201:       IFIRST = 0
202:  450 CONTINUE
203:       RETURN
204:  900 WRITE(6,2000) CTIME
205:       GO TO 920
206:  910 WRITE(6,3000) CTIME
207:  920 WRITE(6,2001) COND(1), DX(1), EMISS, HCOUT, HREC, HW, TREC, TW,
208:      1 NSTEP
209:       WRITE(6, 3001) COND(IMAX), DX(IMAX), EMISIN, HCIN, TSINK, TGAS,
210:      1 NSTEP
211:       WRITE (6,4000) (T(I), I = 1, IMAX)
212:       NERROR=1
213:       RETURN
214:       END
```

```
      SUBROUTINE CRSFLW(CFFLG,ELL,ELT,EL,ELMBDA,DSUBO, CORNR, UE, PE,
     1RHOE,PU,ALPHA,UDOT,VU,XMACHU,VX)
C
C     CONSTANT WIDTH RECTANGLE - IDEAL GAS
C     CONSTANT WIDTH RECTANGLE - REAL GAS
C     SHARP EDGE DELTA - IDEAL GAS
C     SHARP EDGE DELTA - REAL GAS
C
      IF(ALPHA.LE.0.) GO TO 98
      NCFFLG=CFFLG+.001
      ALPHR=ALPHA*.0174533
      IF(NCFFLG-2) 1,2,10
C
    1 VBAR=(.745+3.14*CORNR/DSUBO)*.447*TAN(ALPHR)
      GO TO 5
    2 IF(UDOT.LE.0.) UDOT=0.31
      EMN=XMACHU*SIN(ALPHR)
      IF(EMN.LT.1.) GO TO 3
      DUDXD=SQRT(2.*(PE-PU)/RHOE)
      GO TO 4
    3 DUDXD= 3.*VU*SIN(ALPHR)
    4 VBAR=2.*UDOT*DUDXD/UE
      IF(NCFFLG.GT.2) GO TO 12
    5 VX=DSUBO/VBAR
      VY=EL/VX
      IF(VY.LT.1.E-5) GO TO 98
      IF(VY.GT.6.)  GO TO 6
      ELL=0.5*(1.-EXP(-2.*VY))*VX
      ELT=(1.-EXP(-VY))*VX
      GO TO 99
    6 ELL=0.5*VX
      ELT=VX
      GO TO 99
C
C     SHARP EDGE DELTA (SWEEP ANGLE LAMBDA)
C
C
   10 IF(NCFFLG-3)11,11,2
   11 BETA=1.+.333*TAN(ALPHR)*TAN(ELMBDA*.0174533)
      GO TO 13
   12 BETA=1.+VBAR*TAN(ELMBDA*.0174533)
   13 ELL=EL/BETA
      ELT=2.*EL/(BETA+1.)
      GO TO 99
C
C
   98 ELL=EL
      ELT=EL
   99 RETURN
      END
```

```
      SUBROUTINE DETRAL(RN,EL,PHI,ENCL,ENCT)
      DIMENSION A(6)
      COMMON/FLWFLD/TINF,PINF,RHOINF,AINF,RHOE,PE,TE,HE,XMUE,UE,RHOO,PO,
     1TO,HO,XMUO,RHOU,TU,HU,XMUU,RHOS,TS,HS,XMUS,RHOR,TR,HR,XMUR,U,XME
     2,REL,HINF,XMUINF,PR,PU,DU,TU,XMUU,XMACHU,UU,HU, ALPHA,
     3RHOSTL,HSTL,TSTL,XMUSTL,RHOSTT,HSTT,TSTT,XMUSTT,HRECL,HRECT,S
     4,GINF,GAMAU,GAMAS,GAMAE,GAMAO,GU,GAMAG,PRL,PRT
      COMMON/ERRFLG/NERROR
      DATA (A(J),J=1,6)/ 1.03754, .0043776,-.6187E-4, .96451, .01107,
     1 -.842558E-4/
      REL=RHOE*UE*EL/XMUE
    1 THETA=1.570796-PHI*.0171453
      IF (PHI.GT.89.) FTR=1.
      IF (PHI.GT.89.) GO TO 2
      C=1./(1.4*XMACHU**2)
      D=(1.-C)*(THETA**2-THETA*SIN(4*THETA)/2.+(1.-COS(4.*THETA))/8)
     1+4.*C*(THETA**2-THETA*SIN(2.*THETA)+(1.-COS(2.*THETA))/2.)
      FTR=2.*THETA*SIN(THETA)*((1.-C)*COS(THETA)**2+C)/SQRT(D)
    2 F3=(HO-HU)/(HRECL-HU)
      CALL FAYRID(RN,ENF)
      PRL=.71
      PRT=.71
      ENCL=ENF*FTR*F3
   10 SUM=0.
      IF(PHI.LT.25.) M=1
      IF(PHI.GE.25.) M=4
      N=M+2
      K=0
      DO 11 I=M,N
      SUM=SUM+A(I)*PHI**(K)
   11 K=K+1
      F=SUM
      RR=RHOE/2.377E-3
      CALL BINTRP(TE,RR,1,HD)
      IF(NERROR.NE.0) RETURN
      ENCT=.933*REL**.8*(1.037*F)*(1.+.58*HD/HO)*XMUE/(EL*PRT**.667)
      S=PRL**.667
   99 RETURN
      END
```

```
      SUBROUTINE DINT(XX,XT,Y1,YT1,ZZ,ZT,ML,NL,Y2,YT2,Y3,YT3,IL,YE,YT4)
C   DOUBLE INTERPOLATION SUBROUTINE.  IF IL=1, THE SECOND INDEPENDENT
C   VARIABLE IS NOT CONSTANT WITH THE FIRST. (THE RANGE OF THE SECOND
C   IS NOT THE SAME AT EACH VALUE OF THE FIRST.)
      DIMENSION ZT(NL),XT(ML,NL),YT1(ML,NL),YT2(ML,NL),YT3(ML,NL)
      DIMENSION YT4(ML,NL)
      IF(ZZ-ZT(1))802,801,801
  801 IF(IL.EQ.1) GO TO 803
      IF(XX.LT.XT(1,1))GO TO 802
  803 DO 800 I=1,NL
      L=I
      LL=I-1
      IF(ZZ-ZT(I))902,804,800
  800 CONTINUE
  802 Y1=.2222E+30
      RETURN
  902 RATIP=(ZZ-ZT(LL))/(ZT(L)-ZT(LL))
      IF(IL)1111,1111,1113
  804 DO 904 J=1,ML
      LM=J
      LLM=J-1
      IF(XX-XT(J,L))905,906,904
  904 CONTINUE
      GO TO 802
  905 RATIO=(XX-XT(LLM,L))/(XT(LM,L)-XT(LLM,L))
      Y1=YT1(LLM,L)+RATIO*(YT1(LM,L)-YT1(LLM,L))
      Y2=YT2(LLM,L)+RATIO*(YT2(LM,L)-YT2(LLM,L))
      Y3=YT3(LLM,L)+RATIO*(YT3(LM,L)-YT3(LLM,L))
      YE=YT4(LLM,L)+RATIO*(YT4(LM,L)-YT4(LLM,L))
      RETURN
  906 Y1=YT1(LM,L)
      Y2=YT2(LM,L)
      Y3=YT3(LM,L)
      YE=YT4(LM,L)
      RETURN
 1111 DO 913 J=1,ML
      LM=J
      LLM=J-1
      IF(XX-XT(J,L))911,912,913
  913 CONTINUE
      GO TO 802
  912 Y1=YT1(LM,LL)-RATIP*(YT1(LM,LL)-YT1(LM,L))
      Y2=YT2(LM,LL)-RATIP*(YT2(LM,LL)-YT2(LM,L))
      Y3=YT3(LM,LL)-RATIP*(YT3(LM,LL)-YT3(LM,L))
      YE=YT4(LM,LL)-RATIP*(YT4(LM,LL)-YT4(LM,L))
      RETURN
  911 RATIO=(XX-XT(LLM,L))/(XT(LM,L)-XT(LLM,L))
      Y4=YT1(LLM,LL)+RATIO*(YT1(LM,LL)-YT1(LLM,LL))
      Y5=YT1(LLM,L)+RATIO*(YT1(LM,L)-YT1(LLM,L))
      Y1=Y4-RATIP*(Y4-Y5)
      Y4=YT2(LLM,LL)+RATIO*(YT2(LM,LL)-YT2(LLM,LL))
      Y5=YT2(LLM,L)+RATIO*(YT2(LM,L)-YT2(LLM,L))
      Y2=Y4-RATIP*(Y4-Y5)
      Y4=YT3(LLM,LL)+RATIO*(YT3(LM,LL)-YT3(LLM,LL))
      Y5=YT3(LLM,L)+RATIO*(YT3(LM,L)-YT3(LLM,L))
      Y3=Y4-RATIP*(Y4-Y5)
      Y4=YT4(LLM,LL)+RATIO*(YT4(LM,LL)-YT4(LLM,LL))
      Y5=YT4(LLM,L)+RATIO*(YT4(LM,L)-YT4(LLM,L))
      YE=Y4-RATIP*(Y4-Y5)
      RETURN
 1113 DO 918 J=1,ML
      IF(XX.LT.XT(1,L))GO TO 802
      LM=J
      LLM=J-1
      IF(XX-XT(J,L))916,917,918
  918 CONTINUE
      GO TO 802
  917 Y5=YT1(LM,L)
      Y7=YT2(LM,L)
      Y9=YT3(LM,L)
      Y0=YT4(LM,L)
      GO TO 1114
  916 RATIO=(XX-XT(LLM,L))/(XT(LM,L)-XT(LLM,L))
      Y5=YT1(LLM,L)+RATIO*(YT1(LM,L)-YT1(LLM,L))
      Y7=YT2(LLM,L)+RATIO*(YT2(LM,L)-YT2(LLM,L))
      Y9=YT3(LLM,L)+RATIO*(YT3(LM,L)-YT3(LLM,L))
      Y0=YT4(LLM,L)+RATIO*(YT4(LM,L)-YT4(LLM,L))
```

```
 1114 DO 921 J=1,ML
      LM=J
      LLM=J-1
      IF(XX-XT(J,LL))919,920,921
  921 CONTINUE
      GO TO 802
  920 Y4=YT1(LM,LL)
      Y6=YT2(LM,LL)
      Y8=YT3(LM,LL)
      YA=YT4(LM,LL)
      GO TO 925
  919 RATIO=(XX-XT(LLM,LL))/(XT(LM,LL)-XT(LLM,LL))
      Y4=YT1(LLM,LL)+RATIO*(YT1(LM,LL)-YT1(LLM,LL))
      Y6=YT2(LLM,LL)+RATIO*(YT2(LM,LL)-YT2(LLM,LL))
      Y8=YT3(LLM,LL)+RATIO*(YT3(LM,LL)-YT3(LLM,LL))
      YA=YT4(LLM,LL)+RATIO*(YT4(LM,LL)-YT4(LLM,LL))
  925 Y1=Y4-RATIP*(Y4-Y5)
      Y2=Y6-RATIP*(Y6-Y7)
      Y3=Y8-RATIP*(Y8-Y9)
      YE=YA-RATIP*(YA-Y0)
      RETURN
      END
```

```
      SUBROUTINE DINT1(XX,XT,Y1,YT1,ZZ,ZT,ML,NL)
C   DOUBLE INTERPOLATION SUBROUTINE.
      DIMENSION ZT(NL),XT(ML,NL) YT1(ML,NL)
      IF(ZZ-ZT(1))802,801,801
  801 IF (XX-XT(1,1)) 805,803,803
  805 Y1=12.7
      RETURN
  802 Y1=.2222E+30
      RETURN
  803 DO 800 I=1,NL
      L=I
      LL=I-1
      IF(ZZ-ZT(I))902,804,800
  800 CONTINUE
      GO TO 902
  902 RATIP=(ZZ-ZT(LL))/(ZT(L)-ZT(LL))
      GO TO 1113
  804 DO 904 J=1,ML
      LM=J
      LLM=J-1
      IF(XX-XT(J,L))905,906,904
  904 CONTINUE
      GO TO 802
  905 RATIO=(XX-XT(LLM,L))/(XT(LM,L)-XT(LLM,L))
      Y1=YT1(LLM,L)+RATIO*(YT1(LM,L)-YT1(LLM,L))
      RETURN
  906 Y1=YT1(LM,L)
      RETURN
 1113 IF (XX-XT(1,L)) 805,1115,1115
 1115 DO 918 J=1,ML
      LM=J
      LLM=J-1
      IF(XX-XT(J,L))916,917,918
  918 CONTINUE
      GO TO 802
  917 Y5=YT1(LM,L)
      GO TO 1114
  916 RATIO=(XX-XT(LLM,L))/(XT(LM,L)-XT(LLM,L))
      Y5=YT1(LLM,L)+RATIO*(YT1(LM,L)-YT1(LLM,L))
 1114 DO 921 J=1,ML
      LM=J
      LLM=J-1
      IF(XX-XT(J,LL))919,920,921
  921 CONTINUE
      GO TO 802
  920 Y4=YT1(LM,LL)
      GO TO 925
  919 RATIO=(XX-XT(LLM,LL))/(XT(LM,LL)-XT(LLM,LL))
      Y4=YT1(LLM,LL)+RATIO*(YT1(LM,LL)-YT1(LLM,LL))
  925 Y1=Y4-RATIP*(Y4-Y5)
      RETURN
      END
```

```
      SUBROUTINE DOWNID(ANGLE)
      REAL MUSTRM,MFRSTM
      REAL MDNSTM
      COMMON/ DNSTRM/TDNSTM,PDNSTM,DDNSTM,MDNSTM,VDNSTM,SDNSTM,HDNSTM,
     *ADNSTM,GDNSTM
      COMMON/FRSTM/ TFRSTM,PFRSTM,DFRSTM,MFRSTM,VFRSTM,SFRSTM,HFRSTM,
     1AFRSTM
      COMMON/TOTAL/ HTOTAL,PTOTAL,TTOTAL,RHOTOT,GTOTAL
      COMMON/ERRFLG/NERROR
      GDNSTM=1.4
      GTOTAL=1.4
      MUSTRM = MFRSTM*SIN(ANGLE)
      PDNSTM = PFRSTM *(2.8*MUSTRM**2 -.4)/ 2.4
      TDNSTM =  TFRSTM*PDNSTM/ PFRSTM *(.4 *MUSTRM**2 +2.)/(2.4*MUSTRM
     1**2)
      MDNSTM = SQRT(TFRSTM/ TDNSTM*(MFRSTM**2 -2./2.4*(PDNSTM/ PFRSTM
     1  - TDNSTM/ TFRSTM *PFRSTM/ PDNSTM)))
      PTOTAL =  PDNSTM*(1. + .2*MDNSTM**2)**3.5
      DDNSTM=PDNSTM/(32.2*53.35*TDNSTM)
      ADNSTM=49.02*SQRT(TDNSTM)
      VDNSTM=MDNSTM*ADNSTM
      HDNSTM=0.24*TDNSTM
      RETURN
      END
```

```
      SUBROUTINE DRIVEL(DTEMP, G, ZPLUS, ZMINUS, QO, QI, T, NSTEP, IMAX)
C
C
C     THIS SUBROUTINE COMPUTES DERIVATIVES AT EACH NODE AT RUNGE-KUTTA
C     STEP(NSTEP) USING INTERIOR TEMPERATURES COMPUTED BY THE GAUSSIAN
C     ELIMINATION TECHNIQUE.
C
C
      DIMENSION DTEMP(IMAX,4), G(25), ZPLUS(25), ZMINUS(25),T(25)
      DTEMP(1,NSTEP) = ZPLUS(1)/G(1) * (T(2)-T(1)) + QO/G(1)
      IMINUS = IMAX - 1
      IF(IMAX.EQ.2) GO TO 101
      DO 100 I = 2, IMINUS
      DTEMP(I,NSTEP) = (ZPLUS(I)*T(I+1) -(ZPLUS(I)+ZMINUS(I))*T(I) +
     1 ZMINUS(I)*T(I-1)) / G(I)
  100 CONTINUE
  101 DTEMP(IMAX,NSTEP) = ZMINUS(IMAX)/G(IMAX) * (T(IMAX-1) - T(IMAX))
     1 - QI / G(IMAX)
      RETURN
      END
```

```
1:      SUBROUTINE EDPARM(ALPHA,PARA1)
2:      DIMENSION DEFL(6),PRMLOG(6), XX(6)
3:      DATA (DEFL(K),K=1,6)/ 0.,30.,40.,50.,60.,70./
4:      DATA(PRMLOG(K),K=1,6)/ 1.,1.,1.0412,1.1383,1.30103,1.69897/,N/6/
5:      CALL TBLIN(ALPHA,DEFL,PRM,PRMLOG,X,XX,N)
6:      PARA1=10.**PRM
7:      RETURN
8:      END
```

```
 1:       SUBROUTINE FINALT(TSAVE, DTEMP, IMAX, NCOL, DT, T)
 2:C
 3:C
 4:C      THIS SUBROUTINE DETERMINES THE FINAL TEMPERATURES AT THIS
 5:C      COMPUTATION TIME AS FUNCTIONS OF PREVIOUS TEMPERATURES AND THE
 6:C      DERIVATIVES COMPUTED AT RUNGE-KUTTA STEPS 1, 2, 3, AND 4.
 7:C
 8:C
 9:       DIMENSION TSAVE(IMAX), T(IMAX), DTEMP(IMAX,NCOL)
10:       DO 100 I = 1, IMAX
11:       T(I) = TSAVE(I) + DT/ 6. * (DTEMP(I,1) +  2. * DTEMP(I,2)
12:      1        +  2 * DTEMP(I,3) + DTEMP(I,4))
13:   100 CONTINUE
14:       RETURN
15:       END
```

```
      SUBROUTINE FLOW(FF,ALFA,BETA)
      REAL MU, MD , ML , ME
      DIMENSION FF(9),ALFA(9),NF(9)
      COMMON/FLWFLD/TINF,PINF,RHOINF,AINF,RHOE,PE,TE,HE,XMUE,UE,RHOO,PO,
     1TO,HO,XMUO,RHOW,TW,HW,XMUW,RHOS,TS,HS,XMUS,RHOR,TR,HR,XMUR,U,XME
     2,REL,HINF,XMUINF,PR,PU,DU,TU,XMUU,XMACHU,UU,HU, ALPHA,
     3RHOSTL,HSTL,TSTL,XMUSTL,RHOSTT,HSTT,TSTT,XMUSTT,HRECL,HRECT,S
     $,GINF,GAMAU,GAMAS,GAMAE,GAMAO,GW,GAMAG,PRL,PRT
      COMMON/DNSTRM/TD,PD,DD,MD,UD,SD,HD,AD,GAMAD
      COMMON/ FRSTM/TFRSTM,PFRSTM,DFRSTM,MU,UFRSTM,SU,HFRSTM,AU
      COMMON/TOTAL/ HTOTAL,PTOTAL,TTOTAL,RHOTOT,GTOTAL
      COMMON/CYL/ HSL,PSL,RHOSL,XMUSL,TSL,USL
      COMMON/STAG/PSTAG,RHOSTG,TSTG,XMUSTG
      COMMON/FLAG/ IDEAL
      COMMON/ERRFLG/NERROR
      COMMON/HFLAG/ NHFLAG
      DATA PI/3.141592654/
      IDEAL=0
      GR=32.2$53.35
      DO 8 K=1,9
    8 NF(K)=FF(K)+.001
      HINF=.24$TINF
      CALL HANSEN(XMUINF,PINF,TINF)
      K=1
      GINF=1.4
      TU=TINF
      PU=PINF
      DU=RHOINF
      MU=U/AINF
      UU=U
      HU=HINF
      AU=AINF
      GAMAU=GINF
      XMUU=XMUINF
      PFRSTM=PU
      TFRSTM=TU
      DFRSTM=DU
      UFRSTM=UU
      HFRSTM=HU
    1 IF(MU.LT.1.) GO TO 20
      IF(NF(K)-36 )2,4,6
    2 CALL PCSW(MU,ALFA(K),1,OFT,BETA)
      IF(NERROR.NE.0) RETURN
      IF(OFT-1.)10,20,5
    4 CALL PCSW(MU,ALFA(K),2,OFT,BETA)
      IF(NERROR.NE.0) RETURN
      IF(OFT-1.)10,20,5
    5 BETA=90.
      GO TO 10
    6 BETA=ALFA(K)
   10 CALL DWNSTM(BETA$PI/180)
      IF(IDEAL-1)30,100,30
C
C     IF MACH NO IS LESS THAN ONE, USE MOD. NEWTONIAN AND LAST SLOPE
C
   20 IF(K.LT.2) GO TO 160
      HO=HTOTAL
      PO=PTOTAL
      RHOO=RHOTOT
      TO=TTOTAL
      GAMAO=GTOTAL
      CALL HANSEN(XMUO,PO,TO)
   22 IF(NF(K+2).EQ.29) GO TO 26
      BETAP=ALFA(K+1)$PI/180
      K=K+2
   27 IF(K.GT.7) GO TO 25
      IF(ALFA(K)-0.)25,25,22
   26 BETAP=(ALFA(K+1)-ALFA(K+2))$PI/180
      IF(BETAP.LT.0.) BETAP=0.
      K=K+3
      GO TO 27
   25 PE=PU+(PO-PU)$SIN(BETAP)$$2
      CALL MOLIER(HE,PE,1,TE,ZE,SD,RHOE,GAMAE)
      IF(IDEAL.GT.0) GO TO 160
      IF(HE.GT.HO) GO TO 23
      IF (BETAP .GE. PI/2) GO TO 23
      UE2=(HO-HE)$50103.
```

```
      UE=SQRT(UE2)
      AE=SQRT(GAMAE*GR*ZE*TE)
      XME=UE/AE
      CALL HANSEN(XMUE,PE,TE)
      GO TO 24
   23 HE=HO
      PE=PO
      TE=TO
      RHOE=RHOO
      XMUE=XMUO
      GAMAE=GAMAO
      UE=0.
      XME=0.
   24 HSL=HE
      PSL=PE
      TSL=TE
      XMUSL=XMUE
      USL=UE
      RHOSL=RHOE
      HD=HU
      PD=PU
      TD=TU
      DD=DU
      MD=MU
      UD=UU
      SD=SU
      AD=AU
      GAMAD=GAMAU
      GAMASL=GAMAE
      PSTAG=PO
      RHOSTG=RHOO
      TSTG=TO
      XMUSTG=XMUO
      GO TO 52
C
C     DETERMINE LOCAL FLOW CONDITIONS
C
   30 IF(NF(K).GT.38 ) GO TO 43
      IF(NF(K+1).EQ.14) GO TO 38
      IF(NF(K+1)-16) 31,32,36
   36 IF(NF(K+1) -18) 46,34,37
   31 ITABLE=3
      GO TO 33
   32 ITABLE=4
   33 CALL PCSU(MU,ALFA(K+1),ITABLE,OFT,PC)
      IF(NERROR.NE.0) RETURN
      BETAP=ALFA(K+1)*PI/180
      IF(OFT-1.)35,20,34
   35 IF(PC.LT.0.) PC=0.
      PL=PU+PC*DU*UU*VU/2.
      GO TO 40
   34 BETAP=ALFA(K+1)*PI/180
      PL=PU+(PTOTAL-PU)*SIN(BETAP)**2
      GO TO 40
   37 PSAV=PTOTAL
      TSV=TTOTAL
      RSV=RHOTOT
      SSV=SD
      GSV=GTOTAL
      HDSV=HD
      PDSV=PD
      TDSV=TD
      DDSV=DD
      GDSV=GAMAD
      XMDSV=MD
      VDSV=VD
      ANGLE=PI/2
      CALL DWNSTM(ANGLE)
      PSTAG=PTOTAL
      PTOTAL=PSAV
      RHOTOT=RSV
      TTOTAL=TSV
      SD=SSV
      GTOTAL=GSV
      HD=HDSV
      PD=PDSV
      TD=TDSV
```

```
155:        DD=DDSV
156:        GAMAD=GDSV
157:        MD=XMDSV
158:        VD=VDSV
159:        BETAP=ALFA(K+1)*PI/180
160:        PL=PU+(PSTAG -PU)*SIN(BETAP)**2
161:        GO TO 40
162:     38 PC=ALFA(K+1)
163:        BETAP=0.
164:        PL=PU+PC*DU*VU**VU/2.
165:     40 CALL MOLIER(HL,PL,1,TL,ZL,SD,DL,GAMAL)
166:        IF(IDEAL.GT.0) GO TO 100
167:        ZTL=ZL*TL
168:        AL=SQRT(GAMAL*GR*ZTL)
169:        IF(HL.GT.HTOTAL) GO TO 41
170:        VL2=(HTOTAL-HL)*50103.
171:        VL=SQRT(VL2)
172:        ML=VL/AL
173:        GO TO 42
174:     41 HL=HTOTAL
175:        PL=PTOTAL
176:        TL=TTOTAL
177:        DL=RHOTOT
178:        GAMAL=GTOTAL
179:        VL=VU*COS(BETAP)**2
180:        IF (BETAP .EQ. 0.) VL=0.
181:        ML=VL/AL
182:        GO TO 42
183:C
184:C       CALCULATE OBLIQUE SHOCK PRESSURE
185:C
186:     46 VLT=VU*COS(BETA*PI/180)
187:        IF(ALFA(K+1).GT.BETA) GO TO 43
188:        ANGL=PI/180*(BETA-ALFA(K+1))
189:        VL=VLT/COS(ANGL)
190:        HL=HTOTAL-VL*VL/50103.
191:        CALL MOLIER(HL,PL,3,TL,ZL,SD,DL,GAMAL)
192:        AL=SQRT(GAMAL*GR*ZL*TL)
193:        ML=VL/AL
194:        BETAP=ALFA(K+1)*PI/180
195:     42 IF(NF(K+2).NE.29) GO TO 44
196:        CALL PMEXPN(ALFA(K+2),HTOTAL,HL,AL,SD,PL,TL,VL,DL,ML,GAMAL)
197:        IF(IDEAL.GT.0) GO TO 100
198:        IF(NERROR.GT.0) GO TO 999
199:        BETAP=(ALFA(K+1)-ALFA(K+2))*PI/180
200:        K=K+3
201:        GO TO 45
202:     44 K=K+2
203:     45 IF(K.GT.9) GO TO 50
204:        IF(ML.LE.0.) GO TO 50
205:        IF(NF(K).LE.0) GO TO 50
206:        PU=PL
207:        TU=TL
208:        DU=DL
209:        HU=HL
210:        AU=AL
211:        VU=VL
212:        MU=ML
213:        GAMAU=GAMAL
214:        PFRSTM=PU
215:        TFRSTM=TU
216:        DFRSTM=DU
217:        VFRSTM=VU
218:        HFRSTM=HU
219:        GO TO 1
220:C
221:C       SWEPT CYLINDER STAG LINE PROPS
222:C
223:     43 CALL MOLIER(HSL,PSL,3,TSL,ZSL,SD,RHOSL,GAMASL)
224:        IF(IDEAL.GT.0) GO TO 100
225:        CALL HANSEN(XMUSL,PSL,TSL)
226:        VSL=VU*COS(BETA*PI/180)
227:        PE=PSL
228:        HE=HSL
229:        TE=TSL
230:        RHOE=RHOSL
231:        XMUE=XMUSL
```

```
      AE=SQRT(GAMASL*GR*TSL)
      UE=USL
      XME=UE/AE
      GAMAE=GAMASL
      PSAV=PTOTAL
      TSV=TTOTAL
      RSV=RHOTOT
      GSV=GTOTAL
      HDSV=HD
      PDSV=PD
      TDSV=TD
      DDSV=DD
      GDSV=GAMAD
      XMDSV=MD
      VDSV=VD
      ANGLE=PI/2
      CALL DWNSTM(ANGLE)
      PSTAG=PTOTAL
      CALL MOLIER(HTOTAL,PSTAG,0,TSTG,ZSTG,SSTG,RHOSTG,GAMSTG)
      IF(IDEAL .NE.0) GO TO 100
      CALL HANSEN(XMUSTG,PSTAG,TSTG)
      HSL=HE
      PTOTAL=PSAV
      RHOTOT=RSV
      TTOTAL=TSV
      GTOTAL=GSV
      HD=HDSV
      PD=PDSV
      TD=TDSV
      DD=DDSV
      GAMAD=GDSV
      MD=XMDSV
      VD=VDSV
      BETAP=BETA*PI/180
      GO TO 51
C
C     DEFINE BOUNDARY LAYER EDGE PROPERTIES
C
   50 PE=PL
      TE=TL
      RHOE=DL
      HE=HL
      UE=VL
      AE=AL
      ME=ML
      XME=ME
      GAMAE=GAMAL
      CALL HANSEN(XMUE,PE,TE)
   51 PO=PTOTAL
      HO=HTOTAL
      RHOO=RHOTOT
      TO=TTOTAL
      GAMAO=GTOTAL
      CALL HANSEN(XMUO,PO,TO)
   52 CALL HANSEN(XMUU,PU,TU)
      XMACHU=MU
C
C     DEFINE WALL PROPERTIES
C
      CALL MOLIER(HW,PE,2,TW,ZW,SW,RHOW,GW)
      IF(IDEAL.GT.0) GO TO 100
      CALL HANSEN(XMUW,PE,TW)
      ALPHA=BETAP/PI*180
C
C      ECKERT REFERENCE ENTHALPY PROPERTIES - REAL GAS
C
      HRECL=HE+0.85*UE*UE/50103.
      HRECT=HE+0.88*UE*UE/50103.
      HSTL=0.5*(HE+HW)+0.22*(HRECL-HE)
      HSTT=0.5*(HE+HW)+0.22*(HRECT-HE)
      CALL MOLIER(HSTL,PE,0,TSTL,ZS,SS,RHOSTL,GAMAS)
      CALL MOLIER(HSTT,PE,0,TSTT,ZS,SS,RHOSTT,GAMAS)
      IF(IDEAL.EQ.1) GO TO 100
      CALL HANSEN(XMUSTL,PE,TSTL)
      CALL HANSEN(XMUSTT,PE,TSTT)
      IF(NHFLAG.EQ.5) GO TO 70
      IF(NHFLAG.EQ.7) GO TO 70
      GO TO 999
```

```
C
C     DEFINE RHO R , MU R PROPERTIES
C
   70 CALL MOLIER(HO,PE,0,TSP,ZSP,SSP,RHOSP,GAMASP)
      IF(IDEAL.GT.0) GO TO 100
      CALL HANSEN(XMUSP,PE,TSP)
      RMSP=RHOSP*XMUSP
      RME=RHOE*XMUE
      RMEE=RMSP*(1.85-.85*(RMSP/RME))
      RMU=RHOU*XMUU
      RORMUR=RMEE*(1.6-.6*(RMEE/RMU))
C
C     ITERATE FOR RHO R
C
      I=1
      RMP=RORMUR/(1.E-13*PE)
      IF(RMP-4.)60,60,61
   60 TRGESS=2.21E4*RMP**(-2.47)
      GO TO 62
   61 TRGESS=2.E7*RMP**(-7.39)
   62 IF(TRGESS.GT. 8000.) TRGESS= 8000.
      CALL MOLIER(HR,PE,2,TRGESS,ZRG,SRG,RHORG,GAMAG)
      IF(IDEAL.GT.0) GO TO 100
      CALL HANSEN(XMURG,PE,TRGESS)
      RMGESS=RHORG*XMURG
      ERR=ABS((RMGESS-RORMUR)/RORMUR)
      IF(ERR.LT..01) GO TO 65
      RESID=RORMUR-RMGESS
      TRGP2=TRGESS*1.05
      TRGM2=TRGESS*0.95
      CALL MOLIER(HR,PE,2,TRGP2,ZRG,SRG,RHORP2,GAMAG)
      IF(IDEAL.GT.0) GO TO 100
      CALL MOLIER(HR,PE,2,TRGM2,ZRG,SRG,RHORM2,GAMAG)
      IF(IDEAL.GT.0) GO TO 100
      DERIVR=(RHORP2-RHORM2)/(.1*TRGESS)
      CALL HANSEN(XMURP2,PE,TRGP2)
      CALL HANSEN(XMURM2,PE,TRGM2)
      DERIVM=(XMURP2-XMURM2)/(.1*TRGESS)
      DERIV=-XMURG*DERIVR-RHORG*DERIVM
      RATE=RESID/DERIV
      TRGESS=TRGESS-RATE
      I=I+1
      IF(I.LT.50) GO TO 62
   65 RHOR=RHORG
      XMUR=XMURG
      TR=TRGESS
      GO TO 999
C
C     IDEAL GAS FLOW PROPERTIES
C
  100 K=1
      TU=TINF
      PU=PINF
      DU=RHOINF
      MU=V/AINF
      VU=V
      HU=HINF
      AU=AINF
      GAMAU=GINF
      PFRSTM=PU
      TFRSTM=TU
      DFRSTM=DU
      VFRSTM=VU
      HFRSTM=HU
  101 IF(MU.LT.1.) GO TO 159
      IF(NF(K)-36 )102,103,106
  102 ITABLE=1
      GO TO 104
  103 ITABLE=2
  104 CALL PCSW(MU,ALFA(K),ITABLE,OFT,BETA)
      IF(NERROR.NE.0) RETURN
      IF(OFT-1.)107,20,105
  105 BETA=90.
      GO TO 107
  106 BETA=ALFA(K)
  107 CALL DOWNID(BETA*PI/180)
C
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
C      DETERMINE LOCAL FLOW CONDITIONS
C
       IF(NF(K).GT.38 ) GO TO 116
       IF(NF(K+1).EQ.14) GO TO 126
       IF(NF(K+1)-16) 108,109,123
  123  IF(NF(K+1)-18) 124,111,125
  108  ITABLE=3
       GO TO 110
  109  ITABLE=4
  110  CALL PCSU(MU,ALFA(K+1),ITABLE,OFT,PC)
       IF(NERROR.NE.0) RETURN
       BETAP=ALFA(K+1)*PI/180
       IF(OFT-1.)112,20,111
  111  BETAP=ALFA(K+1)*PI/180
       PL=PU+(PTOTAL-PU)*SIN(BETAP)**2
       GO TO 113
  112  IF(PC.LT.0.) PC=0.
       PL=PU+PC*DU*VU*VU/2.
       GO TO 113
  125  PSAV=PTOTAL
       TSV=TTOTAL
       RSV=RHOTOT
       ANGLE=PI/2
       CALL DOWNID(ANGLE)
       PSTAG=PTOTAL
       PTOTAL=PSAV
       RHOTOT=RSV
       TTOTAL=TSV
       BETAP=ALFA(K+1)*PI/180
       PL=PU+(PSTAG -PU)*SIN(BETAP)**2
       GO TO 113
  126  PC=ALFA(K+1)
       BETAP=0.
       PL=PU+PC*DU*VU*VU/2.
  113  IF (PL .GT. PTOTAL) PL=PTOTAL                                    RI
       ML=SQRT(5.*((PTOTAL/PL)**(2./7.)-1.))
       HTOTAL=0.24*TINF+V*V/50103.
       TT=HTOTAL/.24
       TL=TT*(PL/PTOTAL)**.286
       DL  =PL/(GR*TL)
       AL=49.02*SQRT(TL)
       HL=0.24*TL
       GAMAL=1.4
       IF(HL.GT.HTOTAL) GO TO 114
       VL=SQRT((HTOTAL-HL)*50103.)
       GO TO 115
  114  HL=HTOTAL
       PL=PTOTAL
       VL=VU*COS(BETAP)**2
       IF (BETAP .EQ. 0.) VL=0.
       ML=VL/AL
       GO TO 115
C
C       CALCULATE OBLIQUE SHOCK PRESSURE
C
  124  VLT=VU*COS(BETA*PI/180)
       IF(ALFA(K+1).GT.BETA) GO TO 116
       ANGL=PI/180*(BETA-ALFA(K+1))
       VL=VLT/COS(ANGL)
       HTOTAL=.24*TINF+V*V/50103.
       HL=HTOTAL-VL*VL/50103.
       IF(HL.LT.0.) GO TO 111
       TL=HL/.24
       PL=PD*(TL/TD)**3.5
       DL=PL/(GR*TL)
       AL=49.02*SQRT(TL)
       ML=VL/AL
       GAMAL=1.4
       BETAP=ALFA(K+1)*PI/186
  115  IF(NF(K+2).NE.29) GO TO 117
       CALL PMID(ALFA(K+2),ML,AL,PL,TL,VL,DL,ML)
       BETAP=(ALFA(K+1)-ALFA(K+2))*PI/180
       K=K+3
       GO TO 118
  117  K=K+2
  118  IF(K.GT.9) GO TO 120
       IF(ML.LE.0.) GO TO 120
```

```
      IF(NF(K).LE.0) GO TO 120
      PU=PL
      TU=TL
      DU=DL
      HU=HL
      AU=AL
      VU=VL
      MU=ML
      GAMAU=GAMAL
      PFRSTM=PU
      TFRSTM=TU
      DFRSTM=DU
      VFRSTM=VU
      HFRSTM=HU
      GO TO 101
C
C     MACH NUMBER LESS THAN ONE( IDEAL GAS
C
  159 IF(K.LT.2) GO TO 160
      HO=HTOTAL
      PO=PTOTAL
      RHOO=RHOTOT
      TO=TTOTAL
      GAMAO=GTOTAL
      GO TO 162
  160 PO=PU*(1.+.2*MU*MU)**3.5
      HO=HU+VU*VU/50103.
      TO=HO/.24
      GAMAO=1.4
  162 CALL HANSEN(XMUO,PO,TO)
  165 IF(NF(K+2).EQ.29) GO TO 166
      BETAP=ALFA(K+1)*PI/180
      K=K+2
  167 IF(K.GT.7) GO TO 168
      IF(ALFA(K)-0.)168,168,165
  166 BETAP=(ALFA(K+1)-ALFA(K+2))*PI/180
      IF(BETAP.LT.0.) BETAP=0.
      K=K+3
      GO TO 167
  168 PE=PU+(PO-PU)*SIN(BETAP)**2
      TO=HO/.24
      GAMAO=1.4
      TE=TO*(PE/PO)**.286
      RHOE=PE/(GR*TE)
      RHOO=PO/(32.2*53.35*TO)
      HE=0.24*TE
      GAMAE=1.4
      IF(HE.GT.HO) GO TO 163
      IF (BETAP .GE. PI/2) GO TO 163
      UE=SQRT((HO-HE)*50103.)
      AE=49.02*SQRT(TE)
      XME=UE/AE
      CALL HANSEN(XMUE,PE,TE)
      GO TO 164
  163 PE=PO
      HE=HO
      TE=TO
      RHOE=RHOO
      XMUE=XMUO
      UE=0.
      VE=VU*COS(BETAP)**2
      XME=0.
  164 HSL=HE
      PSL=PE
      TSL=TE
      XMUSL=XMUE
      USL=UE
      RHOSL=RHOE
      HD=HU
      PD=PU
      TD=TU
      DD=DU
      MD=MU
      VD=VU
      SD=SU
      AD=AU
```

```
      GAMAD=GAMMU
      GAMASL=1.4
      PSTAG=P0
      RHOSTG=RHO0
      TSTG=T0
      XMUSTG=XMU0
      GO TO 121
C
C     SWEPT CYLINDER STAG LINE PROPS
C
  116 VT=V*COS(BETA*PI/180)
      VN=0.
      IF(VT.LT.V) VN=SQRT(V**2-VT**2)
      EMN=VN/A0
      TSL=T0*(1.+.2*EMN*EMN)
      PSL=P0*(TSL/T0)**3.5
      HSL=.24*TSL
      RHOSL=PSL/(GR*TSL)
      GAMASL=1.4
      VSL=VV*COS(BETA*PI/180)
      CALL HANSEN(XMUSL,PSL,TSL)
      PE=PSL
      HE=HSL
      TE=TSL
      RHOE=RHOSL
      GAMAE=GAMASL
      XMUE=XMUSL
      UE=VSL
      XME=VT/A0
      PSAV=PTOTAL
      TSV=TTOTAL
      RSV=RHOTOT
      ANGLE=PI/2
      CALL DOWNID(ANGLE)
      PSTAG=PTOTAL
      HTOTAL=0.24*TINF+V*V/50103.
      TSTG=HTOTAL/.24
      RHOSTG=PSTAG/(GR*TSTG)
      CALL HANSEN(XMUSTG,PSTAG,TSTG)
      PTOTAL=PSAV
      TTOTAL=TSV
      RHOTOT=RSV
      BETAP=BETA*PI/180
      GO TO 119
C
C     DEFINE BOUNDARY LAYER EDGE PROPERTIES
C
  120 PE=PL
      TE=TL
      RHOE=DL
      HE=HL
      AE=AL
      GAMAE=GAMAL
      UE=UL
      ME=ML
      XME=ME
      CALL HANSEN(XMUE,PE,TE)
  119 H0=HTOTAL
      P0=PTOTAL
      T0=H0/.24
      RHO0=P0/(GR*T0)
      GAMA0=1.4
      CALL HANSEN(XMU0,P0,T0)
      CALL HANSEN(XMUU,PU,TU)
C
C     DEFINE WALL PROPERTIES
C
  121 HW=0.24*TW
      GW=1.4
      XMACHW=MU
      RHOW=PE/(GR*TW)
      CALL HANSEN(XMUW,PE,TW)
      ALPHA=BETAP/PI*180
C
C      ECKERT REFERENCE ENTHALPY PROPERTIES - IDEAL GAS
C
```

```
      HRECL=HE+0.85*UE*UE/50103.
      HRECT=HE+0.88*UE*UE/50103.
      HSTL =0.5*(HE+HW)+0.22*(HRECL-HE)
      HSTT =0.5*(HE+HW)+0.22*(HRECT-HE)
      TSTL=HSTL/.24
      TSTT=HSTT/.24
      GAMAS=1.4
      RHOSTL=PE/(1716.48*TSTL)
      RHOSTT=PE/(1716.48*TSTT)
      CALL HANSEN(XMUSTL,PE,TSTL)
      CALL HANSEN(XMUSTT,PE,TSTT)
      IF(NWFLAG.EQ.5) GO TO 150
      IF(NWFLAG.EQ.7) GO TO 150
      GO TO 999
C
C     DEFINE RHO R, MU R PROPERTIES
C
  150 RHOSP=PE/(GR*TO)
      CALL HANSEN(XMUSP,PE,TO)
      RMSP=RHOSP*XMUSP
      RME=RHOE*XMUE
      RMEE=RMSP*(1.85-.85*(RMSP/RME))
      RMW=RHOW*XMUW
      RORMUR=RMEE*(1.60-0.60*(RMEE/RMW))
C
C     ITERATE FOR RHO R AND MU R
C
      I=1
      RMP=RORMUR/(1.E-13*PE)
      IF(RMP-4.)130,130,131
  130 TRGESS=2.21E4*RMP**(-2.47)
      GO TO 132
  131 TRGESS=2.E7*RMP**(-7.39)
  132 IF(TRGESS.GT.10000.) TRGESS=10000.
      RHORG=PE/(GR*TRGESS)
      CALL HANSEN(XMURG,PE,TRGESS)
      RMGESS=RHORG*XMURG
      ERR=ABS((RMGESS-RORMUR)/RORMUR)
      IF(ERR.LT..01) GO TO 135
      RESID=RORMUR-RMGESS
      TRGP2=TRGESS*1.05
      TRGM2=TRGESS*0.95
      DERIVR=-PE/(GR*TRGESS*TRGESS)
      CALL HANSEN(XMURP2,PE,TRGP2)
      CALL HANSEN(XMURM2,PE,TRGM2)
      DERIVM=(XMURP2-XMURM2)/(.1*TRGESS)
      DERIV=-XMURG*DERIVR-RHORG*DERIVM
      RATE=RESID/DERIV
      TRGESS=TRGESS-RATE
      I=I+1
      IF(I.LT.50) GO TO 132
  135 RHOR=RHORG
      XMUR=XMURG
      TR=TRGESS
      HR=.24*TR
      GAMAG=1.4
  999 RETURN
      END
```

```
      SUBROUTINE GAUSS(A,B,C,D,ALPHA,S,T,IMAX)
C
C       THIS SUBROUTINE SOLVES A SYSTEM OF SIMULTANEOUS LINEAR
C       EQUATIONS WITH TRI-DIAGONAL MATRIX BY THE METHOD OF
C       GAUSSIAN ELIMINATION.
C
        DIMENSION A(IMAX),B(IMAX), C(IMAX), D(IMAX), S(IMAX), ALPHA(IMAX)
     1  , T(IMAX)
C
C         A = ARRAY OF FIRST DIAGONAL
C         B = ARRAY OF SECOND DIAGONAL
C         C = ARRAY OF THIRD DIAGONAL
C         T = ARRAY TO CANTAIN SOLUTIONS
C        S = SCRATCH STORAGE
C        ALPHA = SCRATCH STORAGE
C        IMAX = NUMBER OF UNKNOWNS
C
      ALPHA(1) = B(1)
      S(1) = D(1)
      DO  50  I=2 IMAX
      ALPHA(I) = B(I) - A(I)*C(I-1)/ALPHA(I-1)
      S(I) = D(I) - A(I)*S(I-1)/ALPHA(I-1)
   50 CONTINUE
      T(IMAX) = S(IMAX)/ALPHA(IMAX)
      J = IMAX
      DO  100  I=2,IMAX
      J = J-1
      T(J) = (S(J) -C(J)*T(J+1))/ ALPHA(J)
  100 CONTINUE
      RETURN
      END
```

```
 1:       SUBROUTINE HANSEN(XMU,P,T)
 2:C
 3:C      THIS SUBROUTINE CALCULATES VISCOSITY BASED ON HANSEN
 4:C
 5:       COMMON/ERRFLG/ NERROR
 6:       IF(T.GT.0.) GO TO 2
 7:       WRITE(6,1) T
 8:     1 FORMAT(/ 24H TEMP IS ZERO OR NEG, T=  F9.2)
 9:       T=1000.
10:       NERROR=1
11:     2 XMUS=2.27E-8*T**1.5/(198.6+T)
12:       PL=ALOG10(P/2116.)
13:       IF (PL.LT.-3.69897) COEF=1.
14:       IF (PL.LT.-3.69897) GO TO 3
15:       A=(T/1800.*(1.-0.125*PL)-6.5)/(1.5+0.125*PL)
16:       B= 1.+0.023*(T/1800.)*(1.+TANH(A))
17:       C=(T/1800.-14.5-1.5*PL)/(.9+.1*PL)
18:       D=EXP(C)+1.
19:       COEF=B/D
20:       IF(COEF.LT..04) COEF=.04
21:     3 XMU=XMUS*COEF
22:       RETURN
23:       END
```

```
      SUBROUTINE MATRES(MATL,QN,RHOM,CPM,DEL,TDOT,TW,TMAT,CPMAT,NMTL)
      DIMENSION CPMAT(10), TMAT(10),XX(10)
      IF(MATL.GT.0) GO TO 10
      T=TW-459.7
C
C     MATL PROPS INPUT
C
    5 RHO=RHOM
      IF(NMTL.GT.0) GO TO 6
      CP=CPM
      GO TO 100
    6 CALL TBLIN(T,TMAT,CP,CPMAT,X,XX,NMTL)
      GO TO 100
   10 CALL MPROPS(MATL,TW,RHO,CP,X)
C
C     CALCULATE TDOT
C
  100 TDOT=12.*QN/(RHO*CP*DEL)
      RETURN
      END
```

```
      SUBROUTINE MOLIER(H,P,NOPT,T,Z,S,RHO,GAMMA)
C
C     NOPT=0  LOOK UP PROPS BASED ON P AND H
C     NOPT=1  LOOK UP PROPS BASED ON P AND S
C     NOPT=2  LOOK UP PROPS BASED ON P AND T
C     NOPT=3 LOOK UP PROPS BASED ON H AND S
      DIMENSION  FLP(33,20),HZ(33,20),TT(33,20),ZT(33,20),GAME(33,20),
     1ENTRO(33,20),FLPO(660),HZO(660),TTO(660),ZTO(660),GAMEO(660),
     2ENTROO(660),FLPZ(20),HTBL(33),ENTROV(20,33),FLPV(20,33)
      EQUIVALENCE(FLPO,FLP),(HZO,HZ),(TTO,TT),(ZTO,ZT),(GAMEO,GAME),
     1(ENTROO,ENTRO)
      DATA PO,CPOR,HO,SOR,G,R,ALE,RTO,CP/2116.,3.48158,117.346,23.6,
     1132.2,53.35,2.302585,33.705,.23866/
      COMMON/FLAG/ IDEAL,IFP
      IDEAL=0
      Z=1.0
      GAMMA=1.4
      IF(IZ.EQ.33) GO TO 5
      DO 2 K=1,20
      LL=33*(K-1)
      DO 2 L=1,33
      FLPO(LL+L)=FLPZ(K)
      IF(K.EQ.1) GO TO 2
      HZO(LL+L)=HZO(L)
    2 CONTINUE
      IZ=33
      JZ=20
      DO 1 I=1,IZ
      HTBL(I)=HZ(I,1)
      DO 1 J=1,JZ
      ENTROV(J,I)=ENTRO(I,JZ-J+1)
    1 FLPV(J,I)=FLP(I,JZ-J+1)
    5 IF(NOPT.EQ.3) GO TO 40
      PL=ALOG10(P/2116.) + 10.
      IF(NOPT-1) 10,20,30
   10 IF(H.LT.100.) GO TO 100
      CALL DINT(H,HZ,Z,ZT,PL,FLPZ,IZ,JZ,T,TT,S,ENTRO,0,GAMMA,GAME)
      IF(Z-.2222E+30)11,12,12
   11 RHO= P/(32.2*53.35*Z*T)
      GO TO 50
  100 IF(H.LT.0.) GO TO 12
      T=H/CP
      RHO=P/(G*R*T)
  101 S=(CPOR*ALOG10(H/HO)-ALOG10(P/PO))*ALE+SOR
      GO TO 50
   12 IFP=1
      IDEAL=1
      GO TO 50
   20 IF(PL.LT.FLPZ(1)) GO TO 22
      DO 21 J=2,JZ
      IF(PL-FLPZ(J)) 203,202,21
   21 CONTINUE
  202 IF(S-ENTRO(2,J)) 205,204,204
  203 IF(S-ENTRO(2,J-1)) 205,204,204
  204 CALL DINT(S,ENTRO,H,HZ,PL,FLPZ,IZ,JZ,T,TT,Z,ZT,1,GAMMA,GAME)
      IF(H-.2222E+30)11,22,22
  205 H=RTO*CPOR*10**((S-SOR+ALE*ALOG10(P/PO))/(CPOR*ALE))
      T=H/CP
      RHO=P/(G*R*T)
      GO TO 50
   22 IFP=1
      IDEAL=1
      GO TO 50
   30 IF(T.LT.419.) GO TO 301
      CALL DINT(T,TT,H,HZ,PL,FLPZ,IZ,JZ,   Z,ZT,S,ENTRO,1,GAMMA,GAME)
      IF(H-.2222E+30)11,31,31
  301 IF(T.LT.0.) GO TO 31
      H=CP*T
      RHO=P/(G*R*T)
      GO TO 101
   31 IFP=1
      IDEAL=1
      GO TO 50
   40 IF(H.LT.100.) GO TO 401
      CALL DINT1(S,ENTROV,PL,FLPV,H,HTBL,JZ,IZ)
      IF(PL-.2222E+30)41,42,42
   41 IF(PL.GT.12.69897) GO TO 44
      P=10.**(PL-10.)*2116.
```

```
      GO TO 10
401   IF(H.LT.0.) GO TO 42
      ALP=(SOR-S)/ALE+CPOR*ALOG10(H/HO)
      P=PO*10.**ALP
      T=H/CP
      RHO=P/(G*R*T)
      GO TO 50
 42   IFP=1
 49   IDEAL=1
      GO TO 50
 44   IDEAL=2
 50   RETURN
      DATA (FLPZ(J),J=1,20) /6.30103, 6.69897, 7.0, 7.30103, 7.69897, 8.
     10, 8.30103, 8.69897, 9.0, 9.30103, 9.69897, 10.0, 10.30103, 10.698
     297, 11.0, 11.30103, 11.69897, 12.0, 12.30103,12.69897/
      DATA (TTO(L),L=1,204)/     0., 419., 834.,1616.,2339.,3032.,3478.,
     13848.,4025.,4175.,4320.,4468.,4600.,4880.,5148.,5730.,6238.,6565.,
     26836.,7005.,7155.,7270.,7380.,7693.,7911.,8100.,8262.,8410.,8568.,
     38723.,8900.,9140.,9450.,    0., 419., 834.,1616.,2339.,3032.,3517.,
     43907.,4130.,4300.,4460.,4600.,4750.,4940.,5260.,5760.,6300.,6705.,
     56984.,7195.,7350.,7490.,7596.,7927.,8172.,8374.,8550.,8712.,8878.,
     69054.,9250.,9490.,9780.,    0., 419., 834.,1616.,2339.,3032.,3546.,
     73964.,4224.,4390.,4563.,4708.,4865.,5060.,5346.,5775.,6350.,6795.,
     87092.,7305.,7495.,7648.,7772.,8125.,8388.,8595.,8784.,8950.,9135.,
     99324.,9520.,9750.,10030.,   0., 419., 834.,1616.,2339.,3032.,3571.,
     14035.,4295.,4500.,4669.,4830.,4990.,5180.,5450.,5890.,6450.,6870.,
     27218.,7450.,7640.,7790.,7920.,8323.,8604.,8827.,9018.,9216.,9405.,
     39594.,9780.,10030.,10350., 0., 419., 834.,1616.,2339.,3032.,3586.,
     44100.,4410.,4630.,4815.,4985.,5150.,5340.,5594.,5990.,6498.,6995.,
     57353.,7620.,7840.,8015.,8172.,8597.,8901.,9150.,9378.,9576.,9765.,
     69963.,10180.,10420.,10730.,0., 419., 834.,1616.,2339.,3032.,3596.,
     74150.,4485.,4735.,4930.,5100.,5270.,5480.,5724.,6050.,6580.,7050.,
     87470.,7760.,8000.,8190.,8334.,8811.,9144.,9410.,9648.,9846.,
     910060.,10280.,10500.,10740.,11040.,0.,419.,834.,1616.,2339.,3032./
      DATA (TTO(L),L=205,400)/3618.,4208.,4555.,4829.,5040.,5240.,5410.,
     15610.,5872.,6195.,6650.,7165.,7596.,7908.,8150.,8355.,8532.,9036.,
     29414.,9657.,9927.,10160.,10380.,10590.,10820.,11100.,11400.,    0.,
     3 419., 834.,1616.,2339.,3032.,3630.,4259.,4655.,4960.,5202.,5408.,
     45640.,5840.,6066.,6350.,6790.,7250.,7722.,8095.,8360.,8600.,8725.,
     59378.,9756.,10060.,10350.,10580.,10800.,11040.,11300.,11580.,
     611880.,  0., 419., 834.,1616.,2339.,3032.,3640.,4300.,4750.,5060.,
     75323.,5550.,5758.,5990.,6228.,6505.,6900.,7310.,7830.,8215.,8520.,
     88760.,9000.,9630.,10040.,10390.,10660.,10920.,11180.,11420.,
     911680.,11970.,12290.,0., 419., 834.,1616.,2339.,3032.,3654.,4314.,
     14800.,5150.,5445.,5683.,5910.,6150.,6394.,6650.,7045.,7485.,7956.,
     28350.,8680.,8955.,9198.,9864.,10350.,10690.,11000.,11290.,11550.,
     311810.,12100.,12380.,12700.,0.,419., 834.,1616.,2339.,3032.,3654.,
     44328.,4880.,5295.,5598.,5880.,6110.,6355.,6628.,6900.,7250.,7660.,
     58118.,8550.,8910.,9210.,9468.,10230.,10740.,11150.,11480.,11790.,
     612080.,12370.,12650.,12980.,13300.,0.,419.,834.,1616.,2339.,3032.,
     73654.,4416.,4945.,5395.,5724.,6015.,6285.,6540.,6808.,7100.,7450.,
     87810.,8270.,8695.,9085.,9415.,9702.,10510.,11070.,11500.,11870.,
     912200.,12510.,12820.,13110.,13450.,13800.,    0., 419., 834.,1616./
      DATA (TTO(L),L=401,590)/2339.,3032.,3654.,4455.,4980.,5475.,5839.,
     16150.,6450.,6735.,7002.,7300.,7640.,8000.,8433.,8948.,9245.,9600.,
     29900.,10800.,11400.,11880.,12280.,12630.,12970.,13280.,13610.,
     313960.,14310., 0., 419., 834.,1616.,2339.,3032.,3654.,4469.,5010.,
     45548.,5976.,6348.,6655.,6950.,7281.,7575.,7910.,8275.,8658.,9100.,
     59496.,9865.,10188.,11200.,11880.,12420.,12820.,13270.,13600.,
     613960.,14310.,14690.,15080.,0.,419., 834.,1616.,2339.,3032.,3654.,
     74483.,5025.,5580.,6080.,6474.,6830.,7150.,7488.,7800.,8140.,8500.,
     88892.,9300.,9700.,10070.,10404.,11500.,12260.,12640.,13300.,
     913770.,14140.,14500.,14880.,15270.,15660.,    0., 419., 834.,1616.,
     12339.,3032.,3654.,4497.,5038.,5675.,6169.,6580.,6975.,7340.,7686.,
     28008.,8350.,8740.,9108.,9525.,9930.,10310.,10683.,11840.,12650.,
     313280.,13810.,14270.,14700.,15100.,15490.,15890.,16290., 0., 419.,
     4 834.,1616.,2339.,3032.,3654.,4505.,5050.,5725.,6266.,6750.,7188.,
     57566.,7956.,8300.,8670.,9050.,9450.,9850.,10260.,10660.,11052.,
     612290.,13190.,13910.,14500.,15010.,15480.,15930.,16350.,16800.,
     717220.,  0., 419., 834.,1616.,2339.,3032.,3654.,4515.,5075.,5750.,
     86336.,6848.,7220.,7755.,8154.,8540.,8945.,9310.,9720.,10110.,
     910540.,10940.,11340.,12630.,13630.,14400.,15050.,15610.,16110./
      DATA (TTO(L),L=591,660)/16600.,17070.,17520.,17980.,0.,419.,834.,
     11616.,2339.,3032.,3654.,4425.,5110.,5774.,6386.,6935.,7440.,7905.,
     28352.,8755.,9155.,9570.,9990.,10400.,10846.,11230.,11630.,13010.,
     314090.,14940.,15640.,16240.,16830.,17320.,17800.,18300.,18820.,0.,
     4 419., 834.,1616.,2339.,3032.,3654.,4425.,5110.,5790.,6440.,7030.,
     57580.,8090.,8590.,9040.,9490.,9905.,10370.,10800.,11210.,11640.,
     612060.,13540.,14710.,15680.,16480.,17140.,17770.,18360.,18910.,
     719450.,19980./
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159:      DATA (ZTO(L),L=1,249)/6*1.0,1.007,1.024,1.049,1.076,1.103,1.130,
160:     11.156,1.180,1.201,1.210,1.216,1.226,1.238,1.251,1.265,1.280,1.296,
161:     21.358,1.422,1.486,1.551,1.617,1.681,1.746,1.810,1.874,1.934,6*1.0,
162:     31.004,1.020,1.044,1.071,1.098,1.124,1.152,1.176,1.197,1.208,1.214,
163:     41.224,1.235,1.248,1.260,1.275,1.290,1.352,1.416,1.480,1.545,1.609,
164:     51.674,1.738,1.802,1.865,1.925,6*1.0,1.003,1.018,1.040,1.067,1.094,
165:     61.119,1.147,1.171,1.193,1.206,1.213,1.221,1.232,1.244,1.258,1.272,
166:     71.287,1.348,1.411,1.475,1.539,1.604,1.667,1.732,1.795,1.858,1.918,
167:     R6*1.0,1.001,1.016,1.037,1.060,1.088,1.115,1.140,1.165,1.188,1.204,
168:     91.212,1.219,1.229,1.241,1.255,1.268,1.283,1.343,1.406,1.470,1.534,
169:     11.597,1.661,1.725,1.788,1.851,1.909,7*1.0,1.013,1.032,1.056,1.081,
170:     21.108,1.132,1.156,1.181,1.197,1.208,1.216,1.226,1.237,1.249,1.264,
171:     31.277,1.337,1.398,1.461,1.526,1.589,1.652,1.715,1.778,1.840,1.899,
172:     47*1.0,1.012,1.028,1.052,1.076,1.100,1.128,1.152,1.175,1.193,1.205,
173:     51.214,1.223,1.234,1.246,1.259,1.273,1.332,1.393,1.455,1.518,1.582,
174:     61.644,1.707,1.770,1.831,1.891,7*1.0,1.011,1.024,1.047,1.070,1.096,
175:     71.120,1.144,1.169,1.188,1.201,1.211,1.220,1.231,1.242,1.256,1.269,
176:     81.326,1.387,1.449,1.511,1.574,1.636,1.699,1.761,1.822,1.880,7*1.0,
177:     91.010,1.022,1.042,1.063,1.088,1.112,1.136,1.160,1.180,1.196,1.206/
178:      DATA (ZTO(L),L=250,502)/1.215,1.226,1.237,1.249,1.263,1.318,1.378,
179:     11.439,1.500,1.563,1.625,1.687,1.748,1.808,1.867,7*1.0,1.009,1.017,
180:     21.037,1.058,1.080,1.104,1.128,1.152,1.172,1.190,1.201,1.211,1.220,
181:     31.232,1.244,1.258,1.312,1.372,1.431,1.492,1.554,1.616,1.677,1.738,
182:     41.798,1.855,7*1.0,1.008,1.015,1.032,1.052,1.076,1.098,1.121,1.144,
183:     51.164,1.184,1.197,1.207,1.216,1.228,1.240,1.252,1.306,1.364,1.424,
184:     61.484,1.545,1.606,1.667,1.727,1.787,1.844,7*1.0,1.007,1.012,1.026,
185:     71.046,1.066,1.088,1.110,1.133,1.154,1.173,1.188,1.200,1.210,1.220,
186:     81.232,1.245,1.297,1.353,1.412,1.472,1.531,1.592,1.653,1.711,1.770,
187:     91.826,7*1.0,1.005,1.009,1.022,1.040,1.058,1.080,1.101,1.124,1.144,
188:     11.164,1.180,1.193,1.204,1.215,1.227,1.238,1.289,1.345,1.403,1.462,
189:     21.522,1.581,1.640,1.699,1.757,1.812,7*1.0,1.004,1.007,1.018,1.034,
190:     31.052,1.072,1.092,1.115,1.135,1.154,1.172,1.186,1.197,1.208,1.219,
191:     41.231,1.281,1.337,1.394,1.452,1.510,1.569,1.627,1.685,1.742,1.798,
192:     57*1.0,1.003,1.005,1.013,1.027,1.044,1.063,1.081,1.102,1.122,1.140,
193:     61.159,1.174,1.188,1.199,1.210,1.221,1.270,1.324,1.379,1.437,1.494,
194:     71.552,1.609,1.666,1.721,1.777,7*1.0,1.002,1.004,1.012,1.023,1.037,
195:     81.055,1.072,1.092,1.112,1.129,1.148,1.164,1.177,1.189,1.200,1.213,
196:     91.261,1.314,1.368,1.424,1.480,1.537,1.594,1.650,1.705,1.759,7*1.0/
197:      DATA (ZTO(L),L=503,660)/1.001,1.003,1.008,1.019,1.030,1.046,1.064,
198:     11.082,1.098,1.117,1.136,1.152,1.165,1.179,1.191,1.203,1.251,1.302,
199:     21.355,1.410,1.466,1.522,1.577,1.632,1.687,1.739,8*1.0,1.002,1.005,
200:     31.014,1.024,1.037,1.052,1.069,1.085,1.103,1.119,1.136,1.150,1.164,
201:     41.176,1.189,1.235,1.285,1.338,1.390,1.445,1.500,1.553,1.607,1.660,
202:     51.712,8*1.0,1.001,1.003,1.010,1.019,1.030,1.044,1.059,1.075,1.091,
203:     61.107,1.122,1.136,1.150,1.163,1.175,1.223,1.272,1.322,1.375,1.428,
204:     71.480,1.534,1.586,1.639,1.692,9*1.0,1.001,1.007,1.015,1.024,1.037,
205:     81.050,1.064,1.079,1.093,1.108,1.122,1.136,1.148,1.161,1.208,1.256,
206:     91.306,1.357,1.410,1.460,1.512,1.564,1.615,1.665,10*1.,1.003,1.010,
207:     11.019,1.028,1.039,1.050,1.063,1.076,1.090,1.104,1.116,1.128,1.141,
208:     21.187,1.234,1.282,1.332,1.382,1.431,1.480,1.531,1.581,1.630/
209:      DATA (GAMEO(L),L=1,212)/2*1.4,1.390,1.344,1.317,1.295,1.206,1.143,
210:     11.114,1.108,1.108,1.114,1.131,1.169,1.226,1.264,1.238,1.180,1.143,
211:     21.121,1.110,1.103,1.099,1.094,1.092,1.093,1.094,1.096,1.099,1.104,
212:     31.111,1.122,1.138,2*1.4,1.390,1.344,1.317,1.295,1.214,1.149,1.119,
213:     41.113,1.113,1.118,1.131,1.162,1.212,1.262,1.248,1.190,1.152,1.128,
214:     51.116,1.109,1.105,1.098,1.096,1.097,1.098,1.100,1.102,1.107,1.114,
215:     61.124,1.138,2*1.4,1.390,1.344,1.317,1.295,1.220,1.154,1.124,1.117,
216:     71.116,1.121,1.132,1.159,1.203,1.258,1.255,1.198,1.158,1.133,1.121,
217:     81.114,1.109,1.101,1.099,1.100,1.101,1.103,1.105,1.110,1.116,1.126,
218:     91.139,2*1.4,1.390,1.344,1.317,1.295,1.227,1.160,1.130,1.121,1.120,
219:     11.124,1.134,1.156,1.195,1.250,1.261,1.206,1.165,1.140,1.126,1.118,
220:     21.114,1.105,1.102,1.103,1.104,1.106,1.108,1.112,1.118,1.128,1.140,
221:     32*1.4,1.390,1.344,1.317,1.295,1.236,1.169,1.138,1.128,1.125,1.129,
222:     41.137,1.154,1.186,1.237,1.261,1.218,1.174,1.148,1.134,1.125,1.120,
223:     51.110,1.107,1.107,1.108,1.110,1.112,1.116,1.122,1.130,1.142,2*1.4,
224:     61.390,1.344,1.317,1.295,1.244,1.176,1.144,1.133,1.130,1.133,1.140,
225:     71.154,1.181,1.226,1.258,1.227,1.182,1.156,1.140,1.131,1.126,1.114,
226:     81.111,1.111,1.112,1.113,1.116,1.120,1.125,1.133,1.145,2*1.4,1.390,
227:     91.344,1.317,1.295,1.250,1.183,1.151,1.138,1.134,1.137,1.143,1.155/
228:      DATA (GAMEO(L),L=213,276)/    1.179,1.218,1.252,1.236,1.191,1.163,
229:     11.147,1.138,1.131,1.118,1.114,1.114,1.115,1.117,1.120,1.123,1.128,
230:     21.136,1.147,2*1.4,1.390,1.344,1.317,1.295,1.258,1.193,1.161,1.146,
231:     31.140,1.142,1.148,1.157,1.177,1.209,1.244,1.244,1.207,1.177,1.159,
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      31.148,
     41.139,1.124,1.120,1.119,1.120,1.122,1.124,1.128,1.133,1.141,1.150,
     52*1.4,1.390,1.344,1.317,1.295,1.263,1.201,1.169,1.152,1.146,1.147/
      DATA (GAMEO(L),L=277,424)/ 1.152,
     61.160,1.177,1.204,1.237,1.245,1.219,1.189,1.169,1.156,1.145,1.128,
     71.124,1.123,1.124,1.126,1.128,1.132,1.137,1.143,1.154,2*1.4,1.390,
     81.344,1.317,1.295,1.267,1.210,1.177,1.159,1.152,1.152,1.156,1.163,
     91.178,1.200,1.230,1.242,1.226,1.201,1.179,1.164,1.152,1.134,1.128,
     11.127,1.128,1.130,1.132,1.136,1.140,1.147,1.156,2*1.4,1.390,1.344,
     21.317,1.295,1.271,1.223,1.188,1.168,1.160,1.159,1.161,1.169,1.180,
     31.197,1.221,1.236,1.231,1.214,1.192,1.174,1.162,1.141,1.135,1.133,
     41.133,1.136,1.138,1.142,1.146,1.152,1.161,2*1.4,1.390,1.344,1.317,
     51.295,1.273,1.232,1.196,1.175,1.167,1.164,1.166,1.173,1.182,1.196,
     61.217,1.231,1.232,1.222,1.202,1.183,1.170,1.147,1.140,1.138,1.138,
     71.140,1.142,1.146,1.150,1.156,1.164,2*1.4,1.390,1.344,1.317,1.295,
     81.274,1.238,1.206,1.183,1.172,1.170,1.171,1.178,1.186,1.197,1.214,
     91.228,1.232,1.226,1.210,1.192,1.179,1.153,1.145,1.143,1.140,1.145/
      DATA(GAMEO(L),L=425,636)/1.147,1.15,1.154,1.160,1.168,2*1.4,1.390,
     11.344,1.317,1.295,1.275,1.244,1.218,1.195,1.182,1.178,1.178,1.183,
     21.190,1.200,1.213,1.225,1.231,1.228,1.218,1.204,1.191,1.162,1.153,
     31.150,1.150,1.150,1.153,1.156,1.160,1.160,1.173,2*1.4,1.390 1.344,
     41.317,1.295,1.275,1.247,1.226,1.204,1.189,1.184,1.184,1.188,1.194,
     51.202,1.213,1.224,1.230,1.230,1.224,1.212,1.200,1.169,1.159,1.155,
     61.155,1.156,1.158,1.161,1.165,1.171,1.177,2*1.4,1.390,1.344,1.317,
     71.295,1.275,1.250,1.232,1.211,1.196,1.190,1.190,1.192,1.198,1.205,
     81.214,1.224,1.230,1.231,1.227,1.219,1.208,1.176,1.165,1.161,1.160,
     91.161,1.163,1.166,1.169,1.175,1.182,2*1.4,1.390,1.344,1.317,1.295,
     11.276,1.253,1.237,1.219,1.205,1.199,1.198,1.199,1.204,1.210,1.216,
     21.224,1.230,1.232,1.231,1.226,1.216,1.186,1.174,1.169,1.167,1.168,
     31.170,1.173,1.177,1.181,1.187,2*1.4,1.390,1.344,1.317,1.295,1.276,
     41.254,1.240,1.223,1.212,1.205,1.203,1.204,1.208,1.214,1.220,1.225,
     51.230,1.233,1.232,1.228,1.221,1.194,1.181,1.176,1.173,1.174,1.176,
     61.179,1.182,1.186,1.192,2*1.4,1.390,1.344,1.317,1.295,1.276,1.255,
     71.241,1.226,1.217,1.211,1.208,1.209,1.212,1.218,1.223,1.226,1.229,
     81.233,1.232,1.229,1.224,1.203,1.188,1.182,1.179,1.180,1.182,1.184,
     91.187,1.191,1.195,2*1.4,1.390,1.344,1.317,1.295,1.276,1.255,1.242/
      DATA(GAMEO(L),L=637,660)/1.228,1.223,1.22,1.214,1.218,1.219,1.223,
     11.228,1.228,1.230,1.233,1.233,1.229,1.227,1.214,1.198,1.191,1.187,
     21.188,1.189,1.192,1.195,1.198,1.202/
      DATA (ENTROO(L),L=1,204)/ 23.68,31.56,33.97,36.43,37.92,39.01,
     139.88,40.87,41.78,42.65,43.50,44.33,45.16,45.94,46.67,47.33,47.94,
     248.50,49.04,49.58,50.10,50.59,51.08,53.05,54.88,56.70,58.46,60.16,
     361.93,63.61,65.22,66.85,68.40,22.76,30.64,33.05,35.51,37.00,38.09,
     438.96,39.93,40.84,41.70,42.54,43.32,44.08,44.84,45.56,46.22,46.81,
     547.39,48.01,48.41,48.95,49.43,49.93,51.84,53.58,55.32,57.08,58.72,
     660.36,62.00,63.58,65.10,66.66,22.07,29.95,32.36,34.82,36.31,37.40,
     738.25,39.21,40.11,40.99,41.79,42.57,43.30,44.01,44.75,45.40,45.99,
     846.53,47.16,47.56,48.02,48.51,49.02,50.85,52.61,54.32,55.99,57.64,
     959.24,60.80,62.33,63.84,65.34,21.37,29.26,31.66,34.12,35.61,36.70,
     137.56,38.50,39.40,40.24,41 01,41.79,42.52,43.22,43.92,44.56,45.15,
     245.70,46.20,46.70,47.17,47.65,48.12,49.94,51.65,53.31,54.96,56.52,
     358.06,59.61,61.10,62.57,63.99,20.46,28.34,30.75,33.21,34.70,35.79,
     436.63,37.57,38.43,39.23,40.01,40.77,41.45,42.14,42.82,43.44,44.02,
     544.57,45.09,45.55,46.03,46.49,46.93,48.73,50.35,51.98,53.54,55.06,
     656.56,58.04,59.46,60.86,62.28,19.77,27.65,30.06,32.52,34.01,35.10,
     735.96,36.89,37.72,38.53,39.27,40.00,40.72,41.36,42.00,42.62,43.20,
     843.74,44.23,44.70,45.18,45.63,46.04,47.77,49.38,50.94,52.49,53.97,
     955.42,56.87,58.23,59.60,60.98,19.07,26.96,29.36,31.82,33.31,34.40/
      DATA (ENTROO(L),L=205,408)/   35.27,36.17,37.01,37.80,38.51,39.22,
     139.90,40.57,41.17,41.80,42.37,42.90,43.39,43.86,44.32,44.76,45.17,
     246.80,48.42,49.93,51.40,52.87,54.31,55.66,57.00,58.36,59.68,18.16,
     326.04,28.45,29.91,32.40,33.49,34.35,35.25,36.08,36.85,37.56,38.25,
     438.88,39.53,40.12,40.64,41.25,41.80,42.30,42.74,43.16,43.61,44.00,
     545.61,47.11,48.62,50.00,51.40,52.80,54.13,55.40,56.68,57.90,17.46,
     625.35,27.75,30.21,31.70,32.79,33.64,34.55,35.38,36.12,36.81,37.50.
     738.13,38.75,39.33,39.90,40.43,40.95,41.42,41.89,42.32,42.72,43.13,
     844.70,46.19,47.62,49.00,50.30,51.64,52.97,54.24,55.42,56.60,16.77,
     924.65,27.06,29.52,31.01,32.10,32.96,33.88,34.66,35.40,36.08,36.72,
     137.37,37.97,38.54,39.11,39.63,40.12,40.60,41.02,41.48,41.88,42.27,
     243.79,45.25,46.64,47.96,49.28,50.52,51.80,53.00,54.20,55.32,15.85,
     323.74,26.14,28.60,30.09,31.18,32.03,32.97,33.75,34.45,35.11,35.76,
     436.35,36.93,37.48,38.04,38.54,39.02,39.48,39.94,40.35,40.75,41.13,
     542.60,43.99,45.33,46.65,47.87,49.06,50.26,51.45,52.58,53.67,15.16,
     623.04,25.45,27.91,29.40,30.49,31.34,32.26,33.04,33.74,34.41,35.00,
     735.61,36.16,36.69,37.23,37.73,38.19,38.66,39.10,39.50,39.89,40.28,
     841.70,43.04,44.35,45.60,46.80,47.98,49.10,50.27,51.35,52.40,14.47,
     922.35,24.76,27.22,28.71,29.80,30.67,31.57,32.35,33.02,33.68,34.28/
      DATA (ENTROO(L),L=409,612)/   34.85,35.40,35.92,36.45,36.92,37.40,
     137.84,38.27,38.68,39.03,39.40,40.81,42.13,43.38,44.56,45.73,46.88,
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```
     247.98,49.07,50.15,51.15,13.55,21.43,23.84,26.30,27.79,28.88,29.75,
     330.64,31.42,32.10,32.72,33.30,33.87,34.39,34.90,35.40,35.86,36.32,
     436.75,37.17,37.57,37.95,38.30,39.65,40.93,42.10,43.27,44.34,45.45,
     546.51,47.53,48.53,49.50,12.86,20.74,23.15,25.61,27.10,28.19,29.01,
     629.97,30.71,31.39,32.00,32.60,33.15,33.68,34.14,34.62,35.10,35.54,
     735.95,36.35,36.77,37.11,37.44,38.77,40.02,41.16,42.27,43.32,44.37,
     845.42,46.38,47.36,48.28,12.16,20.05,22.45,24.91,26.40,27.49,28.36,
     929.25,30.03,30.68,31.30,31.86,32.41,32.93,33.40,33.88,34.31,34.73,
     135.14,35.53,35.91,36.27,36.62,37.90,39.10,40.22,41.31,42.34,43.31,
     244.28,45.27,46.18,47.09,11.25,19.13,21.54,24.00,25.49,26.58,27.44,
     328.34,29.11,29.77,30.37,30.95,31.46,31.96,32.41,32.88,33.30,33.72,
     434.11,34.50,34.84,35.19,35.53,36.77,37.90,38.99,40.00,41.00,41.95,
     542.87,43.79,44.63,45.49,10.55,18.44,20.84,23.30,24.79,25.88,26.75,
     627.64,28.42,29.06,29.69,30.22,30.76,31.22,31.68,32.12,32.54,32.95,
     733.31,33.68,34.05,34.38,34.71,35.93,37.06,38.05,39.08,40.00,40.92,
     841.80,42.64,43.51,44.30, 9.86,17.76,20.15,22.61,24.10,25.19,26.08,
     926.95,27.72,28.37,28.98,29.53,30.04,30.50,30.95,31.40,31.80,32.20/
      DATA (ENTR00(L),L=613,660)/   32.55,32.91,33.24,33.59,33.90,35.09,
     136.16,37.18,38.12,39.01,39.90,40.76,41.57,42.37,43.18, 8.95,16.83,
     219.24,21.70,23.19,24.28,25.15,26.03,26.79,27.44,28.03,28.59,29.10,
     329.56,30.00,30.41,30.80,31.18,31.54,31.89,32.23,32.54,32.84,33.94,
     435.01,35.96,36.90,37.77,38.57,39.33,40.12,40.92,41.68/
      DATA (HZO(L),L=1,33)/0.,100.,200.,400.,600.,800.,1000.,1250.,
     11500.,1750.,2000.,2250.,2500.,2750.,3000.,3250.,3500.,3750.,4000.,
     24250.,4500.,4750.,5000.,6000.,7000.,8000.,9000.,10000.,11000.,
     312000.,13000.,14000.,15000./
      END
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      SUBROUTINE MPROPS(MATL,T,RHO,CP,COND)
C
C     THIS SUBROUTINE CALCULATES MATL PROPS FOR BUILT-IN MATLS AT TEMP T
C
C     BUILT-IN MATLS  1=2024-T4 ALUMINUM, 2= 6AL-4V TITANIUM, 3=
C     RENE 41, 4=INCONEL X-750, 5= TD NI-CR, 6=L-605, 7= FS-85 COLUMBIUM
C     8= CARBON/CARBON, 9=HASTELLOY X, 10= BERYLLIUM, 11=MULLITE HCF ,
C     12= FIBERGLASS HONEYCOMB, 13=HRSI AND LRSI, 14= NOMEX SIP AND
C     FILLER BOND
C
      PARAMETER JMAT=14,JTAB=8*JMAT
      DIMENSION TZ(JTAB),CPZ(JTAB),CZ(JTAB),RHOZ(JMAT),IN(JMAT)
      DATA (IN(J),J=1,JMAT)/6,6,3,5,2,2,5,8,6,7,7,4,8,8/
      DATA (RHOZ(J),J=1,JMAT)/173.,285.,512.,531.3,528.,569.,661.8,
     *103.7,510.,115.5,15.0,4.,9.,17./
      DATA (TZ(J),J=1,JTAB)/
     1-400., -250., -100., 300., 500., 700.,2*0.,
     2-400., -300., -100., 100., 500.,2500.,2*0.,
     3   0.,  800., 2400., 5*0.,
     4-360., -200.,    0.,1000.,2000.,3*0. ,
     5-300.,2500., 6*0.,
     6-300., 2500., 6*0.,
     7   0.,  600., 1200.,2400.,4200.,3*0.,
     8-100.,  300., 1000.,1500.,2000.,2500. ,3000.,4000.,
     9-200.,  500., 1000.,1500.,1700.,1800.,2*0.,
     *-200.,    0.,  250., 700.,1200.,1650.,2330.,0.,
     1   0.,  500., 1000.,1500.,2000.,2500.,3000.,0.,
     2   0.,  200.,  300., 500.,4*0.,
     3-250.,  250.,  750.,1250.,1750.,2300.,2800.,3000.,
     4-250.,    0.,  100., 200., 300., 400., 600.,1000./
      DATA (CPZ(J), J=1,JTAB)/
     1.1186 ,.1384 ,.1906 ,.2202 ,.2377 ,.2652 , 2*0.,
     2.00843,.05953,.1157 ,.1364 ,.1468 ,.150  , 2*0.,
     3.059  ,.1163 ,.2309 , 5*0. ,
     4.060  ,.08022,.09516,.1361 ,.1706 , 3*0. ,
     5.076  ,.168  ,6*0.  ,
     6.0965 ,.164  ,6*0.  ,
     7.010  ,.027  ,.060  ,.141  ,.287  , 3*0. ,
     8.10   ,.277  ,.385  ,.425  ,.4575 ,.480  ,.4975 ,.520,
     9.118  ,.118  ,.129  ,.157  ,.181  ,.210  , 2*0. ,
     *.153  ,.36   ,.51   ,.61   ,.71   ,.80   ,.86   , 0. ,
     1.23   ,.24   ,.25   ,.26   ,.27   ,.28   ,.29   , 0. ,
     2.183  ,.257  ,.279  ,.28   , 4*0.,
     3.070  ,.210  ,.275  ,.296  ,.303  ,.303  ,.303  ,.303,
     4.065  ,.190  ,.258  ,.344  ,.450  ,.575  ,.575  ,.575/
      DATA (CZ(J), J=1,JTAB)/
     1 14.27 , 40.63 , 57.47 , 93.02 , 104.16 , 104.74 , 2*0.,
     2 1.044 , 2.360 , 3.787 , 4.581 , 5.889  , 13.88  , 2*0.,
     3 6.353 , 9.186 , 17.05 , 5*0.  ,
     4 4.100 , 5.390 , 6.366 , 11.97 , 17.63  , 3*0.   ,
     5 7.100 , 18.10 , 6*0.  ,
     6 2.500 , 21.00 , 6*0.  ,
     7 21.80 , 23.80 , 25.80 , 29.80 , 34.70  , 3*0.   ,
     8 9.400 , 9.300 , 8.500 , 5.500 , 4.500  , 4.500  , 6.25 , 7.25,
     9 4.830 , 7.750 , 11.05 , 14.32 , 15.68  , 16.32  , 2*0.,
     * 290.0 , 142.0 , 96.00 , 71.00 , 56.50  , 49.00  , 41.0 , 0.,
     1 .025  , .0408 , .0583 , .100  , .1458  , .1960  , .250 , 0.,
     2.028  , .050  , .078  , .105  , 4*0.,
     3.015  , .0225 , .0325 , .0492 , .0767 , .116  , .180  , .219,
     4.0098 , .0178 , .0208 , .0240 , .0272 , .0303 , .039  , .062/
      K=1+(MATL-1)*8
      RHO=RHOZ(MATL)
      TT=T-459.7
      CALL TBLIN(TT,TZ(K),CP,CPZ(K),CONX,CZ(K),IN(MATL))
      COND=CONX/3600.
      RETURN
      END
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      SUBROUTINE NEWOUT(TOF,CFO2,TUF,TAUW,RED,TDF,Z,XMINF,FF,
     1 ELT,REE,RETHML,ENCLO,AKLZ,QCTOT,QRE,ELTRAN,CPS,RR,SS,
     2 REI,TEF,DELTAS,QCL,AKL2Z,AKL3Z,THETA,PARAO,HFAC1,ELTP,
     3 TINFF,STANT,BETA,CP,TWF,REU,RES,TSF,TRF,ELL,XMUD,TREF,
     4 TRECOV,REO,DELTA,AKT2Z,HFAC2,QRETOT,QNTOT,QCCW,
     5 QN,QCCWT,H,ENCTO,QCTU,AKT3Z,AKTZ,IPAGE)
C
      IMTEGER BDYPNT,TRANME
      PARAMETER J2=500
      DIMENSION TIME1(J2),XME1(J2),REL1(J2),QC1(J2),
     *TREF1(J2),TW1(J2),PE1(J2),CP1(J2),BETA1(J2),ALPHA1(J2),AKLZ1(J2)
     *,HFACZ1(J2),QT(2),TT(2),TW2(J2)
      DIMENSION TRAJ(2,2)
      DATA ((TRAJ(I,J),I=1,2),J=1,2)/12H26BP-14414-1,12H26BP-OFT-1N /     RI
      DIMENSION  FF(9),BDYPNT(4),TRANME(6)
C
      DIMENSION T(25) ,DX    (25),MPFLAG  (25),RHOZ  (25),
     1 CPZ   (25),CONDZ (25),NTAB  ( 5),TIWZ  (50),HCIWZ (50),
     2 TGASZ (50),TSINKZ(50)
      DIMENSION TABT(10,5),TABCP(10,5),TABCX(10,5)
C
C       COMMON BLOCK USED TO TRANSFER INPUT DATA TO WRINP
C            AND SETMUP ROUTINES
C
      COMMON/COMUN/T1,DT1,T2,DT2,T3,DT3,T4,DTCALC,DTEMAX,ATFLAG,HTFLAG,
     1 RN,EL,PARA1,ENL,ENT,PHI,AKL,AKT,PARA2,EMATL,DEL,EMIS,TIN,RHOM,
     2 CPM,TRFLAG,ELFAC,VRLFLG,ATRE,GF(6),ALFA(9),HH(3),HFAC,ENTR,
     3 TZ(50),ZZ(50),VZ(50),CFFLG,DSUBO,ELMBDA,UDOT,CORNR,IOPT,CONFLG,
     4 ENT1,TA(10),A1(10),A2(10),A3(10),A4(10),A5(10),A6(10),A7(10),
     5 A8(10),A9(10),NTFAC,OUTPUT,REIRO,REIRIM,LNGPLT,ENVIR,RANFLG,ENT2,
     6 TK1(10),AKL2(10),AKT2(10),TK2(10),ENM3,TMACH(10),AKL3(10),
     7 AKT3(10),HFACT(9),ARIDEF,ALFA0T(50),DELTAT(50),FSPRES(50),
     8 ARIQ,ALFA1,AKL2Z1,HSLP1,ALFA2,AKL2Z2,HSLP2,HSLP3,ARIR,ENT3,
     9 TMZ(10),RMZ(10),ELZ(10),PHIZ(10),EMIZ(10),ALFA1R,REFAC1,RSLP1,
     * ALFA2R,REFAC2,RSLP2,RSLP3,ARIT,ALFA1T,ENMTL,TMAT(10),CPMAT(10),
     * PARA11,PSLP1,ALFA2T,PARA12,CPSLP2,PSLP2,PSLP3,ARIC,ALFA1C,CPCPS1,
     * CPSLP1,ALFA2C,CPCPS2,CPSLP3,ENALTZ,FSALT(50),FSTEMP(50),
     * IREST1(5), REST1(150)
C
C       INPUT/OUTPUT DESCRIPTION OF NAMELIST
C
C
C       COMMON BLOCK DIBUJO USED IN PPLOT AND DRAW ROUTINES
C
      COMMON/DIBUJO/BDYPNT,TRANME,ICASE
C
C
C
      COMMON/FLWFLD/TINF,PINF,RHOINF,AINF,RHOE,PE,TE,HE,XMUE,UE,RHOO,PO,
     1TO,HO,XMUO,RHOW,TW,HW,XMUW,RHOS,TS,HS,XMUS,RHOR,TR,HR,XMUR,U,XME
     2,REL,HINF,XMUINF,PR,PU,DU,TU,XMUU,XMACHU,VU,HU, ALPHA,
     3RHOSTL,HSTL,TSTL,XMUSTL,RHOSTT,HSTT,TSTT,XMUSTT,HRECL,HRECT,S
     *,GINF,GAMAU,GAMAS,GAMAE,GAMAO,GU,GAMAG,PRL,PRT
      COMMON/HANDY/IMAX,DX,T,MPFLAG, NTIWZ,TSYNK,EMISIN,HCIW
     1,TGSF,TIWZ,HCIWZ,TGASZ,TSINKZ,TWI,TSINK,TGAS,HCIN,
     2 IFIRST,DELT
      COMMON/DNSTRM/TD,PD,DD,XMD,VD,SD,HD,AD,GAMAD
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      COMMON/ THICK/ DTEQ, TDOT, TRE, QC, QR, ENC, EMISS, HRECOV,
     1 DT, TIME, PL, DTO, DTI, TEQ2
      COMMON/ERRFLG/NERROR
      COMMON/FLAG/ IDEAL,IFP
      COMMON/NFLAG/ NNFLAG
      COMMON/OPTT/                TOPT,PERCNT,DELO,TI,
     1            SIGMA, EMMY, MATL, NATL, ROOM, CMM, ICANT, ITRIED
      COMMON/ARRAY/QC1,TIME1,BETA1,ALPHA1,AKLZ1,
     *HFACZ1,XME1,REL1,PE1,CP1,TW1,TREF1,QT,TT,TW2,QC1T
      COMMON/MAX/QM,BETAM,AKLZM,HFACZM,PEM,CPPM,TREFM
      COMMON/PLOTT/JRCD,IT,NT,NT2,NFF,PCT
      COMMON/FFMUM/HSUBD,ALEW
      COMMON/PROPS/ RHOZ, CPZ, CONDZ, TABT, TABCP, TABCX,NTAB
      DATA ISAVED/ 0/, ITRIED/ 0/
      IF(IPAGE .EQ. 0) GO TO 922
      IPAGE=0
      GO TO 926
  922 CONTINUE
      WRITE(6,50)
      IPAGE=1
  926 CONTINUE
   50 FORMAT(1H1)
      WRITE(6,919) TIME,Z
  919 FORMAT(/6H TIME=,F6.0,5X,2HZ=,F8.0/)
      WRITE(6,90)TIME,Z,VMAX,SD,RN,EL,PHI,ALPHA,BETA,EMIS
C
C
      WRITE(6,91)SD,RN,PR,EL,U,XMINF,REI,PINF,GINF,HINF,TINFF,RHOINF,
     1 XMUINF,STANT,PHI
   91  FORMAT(2X'VELOCITY',4X,'MACH',4X,'RE/FT',5X,'PRESSURE',4X,'GAMMA',
     1 3X,'ENTHALPY',3X,'TEMP',6X,'RHO',8X,'MU',7X,'S/R    =',F7.2,
     2 4X,'R      =',G9.4/93X,7HPR     =,F6.4,5X,7HL        =,G9.4/
     3 4H I   ,F6.0,2X,F6.2,2X,E9.4,2X,G9.4,2X,F7.4,4X,F7.0,2X,F6.0,2X,
     4 2(E9.4,2X), 1X,7HST     =,E9.4,2X,7HPHI    =,F7.2)
C
C  90 FORMAT(//6H TIME=F6.0,4H  Z=F8.0,7H  VMAX=F7.0,8H  S/R E=F6.2,
C    *4H  R=G8.3,4H  L=G9.4,6H  PHI=F7.2,8H  ALPHA=F7.2,7H  BETA=F6.2,
C    *8H  EMS*F=F6.4)
C     WRITE(6,91)XMINF,REI,PINF,GINF,HINF,TINFF,RHOINF,XMUINF,PR
C  91 FORMAT(5H M I=F6.2,7H  RE I=E9.4,6H  P I=G9.4,6H  G I=F6.3,6H  H I
C    *=F7.0,6H  T I=F7.0,8H  RHO I=E9.4,7H  MU I=E9.4,8H  PR   =E9.4)
C     WRITE(6,92)U,REO,PO,GAMAO,HO,TOF,RHOO,XMUO,STANT
C
      WRITE(6,92)REO,PO,GAMAO,HO,TOF,RHOO,XMUO,CFO2,EMIS
   92  FORMAT(2H O,18X,E9.4,2X,G9.4,2X,F7.4,4X,F7.0,2X,F6.0,2X,
     1 2(E9.4,2X),1X, 7HCF/2  =,E9.4,2X,'EMIS  =',F9.4)
C
C  92 FORMAT(5H U I=F6.0,7H  RE O=E9.4,6H  P O=G9.4,6H  G O=F6.3,6H  H O
C    *=F7.0,6H  T O=F7.0,8H  RHO O=E9.4,7H  MU O=E9.4,8H  ST   =E9.4)
C     WRITE(6,93)XMACHU,REU,PU,GAMAU,HU,TUF,DU,XMUU,CFO2
C
      WRITE(6,93)XMACHU,REU,PU,GAMAU,HU,TUF,DU,XMUU,
     1 2(E9.4,2X))
   93  FORMAT(2H U,10X,F6.2,2X,E9.4,2X,G9.4,2X,F7.4,4X,F7.0,2X,F6.0,2X,
C
C  93 FORMAT(5H M U=F6.2,7H  RE U=E9.4,6H  P U=G9.4,6H  G U=F6.3,6H  H U
C    *=F7.0,6H  T U=F7.0,8H  RHO U=E9.4,7H  MU U=E9.4,8H  CF/2 =E9.4)
C     WRITE(6,94)XMD,RED,PD,GAMAD,HD,TDF,DD,XMUD,TAUW
C
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      WRITE(6,94) VD,XMD,RED,PD,GAMAD,HD,TDF,DD,XMUD,TAUW,ALPHA
 94   FORMAT(4H D   ,F6.0,2X,F6.2,2X,E9.4,2X,G9.4,2X,F7.4,4X,F7.0,
     1 2X,F6.0, 2X,2(E9.4,2X),1X,'TAU W =',E9.4,2X,'ALPHA =',F7.2)
C
C  94 FORMAT(5H M D=F6.2,7H  RE D=E9.4,6H  P D=G9.4,6H  G D=F6.3,6H  H D
C    *=F7.0,6H  T D=F7.0,8H  RHO D=E9.4,7H  MU D=E9.4,8H  TAU W=E9.4)
      WRITE(6,95) UE,XME,REE,PE,GAMAE,HE,TEF,RHOE,XMUE,DELTA
C
      WRITE(6,95) UE,XME,REE,PE,GAMAE,HE,TEF,RHOE,XMUE,DELTA,BETA
 95   FORMAT(4H E   ,F6.0,2X,F6.2,2X,E9.4,2X,G9.4,2X,F7.4,4X,F7.0,2X,
     1 F6.0,2X, 2(E9.4,2X),1X,7HDELTA =,F6.4,5X,7HBETA  =,F7.2)
C
C  95 FORMAT(5H M E=F6.2,7H  RE E=E9.4,6H  P E=G9.4,6H  G E=F6.3,6H  H E
C    *=F7.0,6H  T E=F7.0,8H  RHO E=E9.4,7H  MU E=E9.4,8H  DELTA=E9.4)
      WRITE(6,96)VD, REL, CP,GW,HW,TWF,RHOW,XMUW,DELTAS
C  96 FORMAT(5H V D=F6.0,7H  RE E=E9.4,6H  C P=G9.4,6H  G W=F6.3,6H  H W
C
      WRITE(6,96)REL,CP,GW,HW,TWF,RHOW,XMUW,DELTAS
C
 96   FORMAT(2H W,14X,'X L=',E9.4,1X,'C P=',F6.3,2X,F7.4,4X,F7.0,2X,F6.0
     1 ,2X,2(E9.4,2X),1X,'DEL * =',F6.4)
C
C    *=F7.0,6H  T W=F7.0,8H  RHO W=E9.4,7H  MU W=E9.4,8H  DEL *=E9.4)
      WRITE(6,97)UE,RES,RETHML,GAMAS,HS,TSF,RHOS,XMUS,THETA
C  97 FORMAT(5H V E=F6.0,7H  RE *=E9.4,9H  RET/ML=F6.1,6H  G *=F6.3,
C    *                                                      6H  H *
C    *=F7.0,6H  T *=F7.0,8H  RHO *=E9.4,7H  MU *=E9.4,8H  THETA=E9.4)
C
      WRITE(6,97)RES,GAMAS,HS,TSF,RHOS,XMUS,THETA,ALEW,HSUBD
C
 97   FORMAT(2H *,18X,E9.4,13X,F7.4,4X,F7.0,2X,F6.0,2X,2(E9.4,2X),1X,
     1 'THETA =',F6.4,5X,'LEWIS =',F8.3/111X,'HDS   =',F6.0)
C
      IF(NHFLAG .EQ. 5 .OR. NHFLAG .EQ. 7)
     *WRITE(6,98)            GAMAG,HR,TRF,RHOR,XMUR
C  98 FORMAT(42X,                                    6H  G R=F6.3,6H  H R
C    *=F7.0,6H  T R=F7.0,8H  RHO R=E9.4,7H  MU R=E9.4)
C
 98   FORMAT(2H R,40X,F7.4,4X,F7.0,2X,F6.0,2X,2(E9.4,2X))
C
      IF(CFFLG.GT.0.) WRITE(6,201) ELL,ELTP
201   FORMAT(27H CROSSFLOW LAMINAR LENGTH = F9.4,19H,TURBULENT LENGTH =
     1F9.4)
      IF(VRLFLG.GT.0.) WRITE(6,202) ELT,ELTRAN,ELTP
202   FORMAT(12H VIRTUAL L =F8.3,16H  L TRANSITION = F8.3,11H L UNCORR =
     1F8.3)
      IF(NT1.GT.0) WRITE(6,203) FF,ALFA
203   FORMAT(/13X,1H1,9X,1H2,9X,1H3,9X,1H4,9X,1H5,9X,1H6,9X,1H7,9X,1H8,
     *9X,1H9,/ 8H FF FLAG,F6.0,8F10.0/6H ANGLE,9F10.2)
      WRITE(6,204) ENCLO,HRECL,QCL,AKL2Z,AKL3Z,AKLZ,HFAC1,PARAO,EMCTO,
     *HRECT,QCTU,AKT2Z,AKT3Z,AKTZ,HFACZ,PCT
C204 FORMAT(/ 7H HC L =E9.4,12H  HRECOV L =E9.4,8H  QC L =E9.4,
C    *9H  K L 2 =G8.3,8H K L 3 =F6.3,7H  K L =F6.3,10H  Q FAC1 =F6.3,
C    *9H  PARA  =G9.4/
C    *          7H HC T =E9.4,12H  HRECOV T =E9.4,8H  QC T =E9.4,
C    *9H  K T 2 =G8.3,8H K T 3 =F6.3,7H  K T =F6.3,10H  Q FAC  =F6.3,
C
C
```

```
      WRITE(6,204)
     1 EMCLO,HRECL,QCL,AKL,AKL2Z,AKL3Z,AKLZ,HFAC,HFAC1,HFACZ,PCT,
     2 EMCTO,HRECT,QCTU,AKT,AKT2Z,AKT3Z,AKTZ,HFAC,HFAC1,HFACZ,
     3 PARAO,RETHAL,REL
 204  FORMAT(15X,'H',10X,'HR',8X,'QC',8X,'K1',6X,'K2',6X,'K3',6X,'K',
     1 6X,'HFAC',4X,'HFAC1',3X,'HFACZ'/
     2 ' LAMINAR    ',3(E9.4,2X),7(F6.3,2X),11X,'PCT    =',F8.3/
     3 ' TURBULENT  ',3(E9.4,2X),7(F6.3,2X),11X,'PARA   =',G8.4/
     4 111X,'RET/AL=',G8.4/111X,'RE E  =',E8.4)
C
      WRITE(6,105)  QC,QCTOT,EMC,HRECOU,QRE,QRETOT,H,TRECOU,TDOT,
     1 QR,TREF,QN,QNTOT,QCCW,QCCWT,IT
C
C
 105  FORMAT(14X,1HQ,8X,5HQ TOT/
     1 5H CONV,5X,F8.3,2X,F8.0,4X,6HHC(H)=,
     2 E9.4, 2X,9HH RECOU =,F7.1,/7H RAD EQ,3X,F8.3,2X,F8.0,4X,6HHC(T)=,
     3 E9.4, 2X,9HT RECOU =,F7.0,46X,'TDOT   =',F7.3/
     4 4H RAD,6X,F8.3,3(X,9HT RAD EQ=,F7.0/
     5 4H MET,6X,F8.3,2X,F8.0,2X,/
     6 4H CW ,6X,F8.3,2X,F8.0,83X,7HIT     =,I5)
C
C    1,9H  PCT T =F6.3)
C     WRITE(6,105) EMC,HRECOU,QC,QN,QR,QRE,QCCW,TDOT
C105 FORMAT(/,8H HC (H)=E10.5,10H  H RECOU=F7.0,9H  Q CONV=F7.3,
C    1,9H  Q MET =F7.3,9H  Q RAD =F7.3,11H  Q RAD EQ=F7.3,9H  QC CW =F7.3
C    2,8H  T DOT=F7.3)
C     WRITE(6,106) H,TRECOU,QCTOT,QNTOT,TREF,QRETOT,QCCWT,IT
C106 FORMAT(  8H HC (T)=E10.5,10H  T RECOU=F7.0,9H  QC TOT=F7.0,
C    1,9H  QN TOT=F7.0,9H  TRE   =F7.1,11H  QRE TOT =F7.0,9H  QC CWT=F7.0
C    2,8H  IT    =I7,/)
      RETURN
      END
```

```
      SUBROUTINE NEWT(A, B, C, T, ICANT)
C
C
C     THIS SUBROUTINE EMPLOYS THE NEWTON-RAPHSON METHOD FOR FINDING
C     REAL POLYNOMIAL ROOTS TO COMPUTE WALL OR EQUILLIBRIUM TEMPERATURES
C
C
      ICANT = 0
      DO 100  N = 1, 50
      DELTAT = (-A * T**4 - B * T + C)/ (-4. * A * T**3 - B)
      T = T - DELTAT
      IF (ABS(DELTAT/ T) .LT. .001) RETURN
      IF (T .LE. 0.) T = (T + DELTAT)/ 2.
  100 CONTINUE
C
C
C     CONVERGENCE HAS NOT BEEN OBTAINED IN FIFTY ITERATIONS. SET FLAG
C     AND RETURN.
C
C
      WRITE(6,200)A,B,C,T,DELTAT
  200 FORMAT(1H , 9X, 22HNEWTON RAPHSON GARBAGE, 1X, 2HA=, E9.3, 2HB=,
     1E9.3, 2HC=, E9.3, 2HT=, E9.3, 7HDELTAT=, E9.3)
      ICANT = 1
      RETURN
      END
```

```
      SUBROUTINE OPTMYZ(M)
C
C
C     THIS SUBROUTINE PERFORMS THE OPTIMIZATION PROCEDURE.
C
C
      COMMON/ THICK/  DTEQ, TDOT, TRE, QC, QR, ENC, EMISS, HRECOV,
     1 DT, TIME, PL, DTO, DTI, TEQ2
      COMMON/OPTT/                TOPT,PERCNT,DELO,TI,
     1            SIGMA, EMIS, MATL, NMTL, RHOM, CPM, ICANT, IDID
      COMMON/ FLWFLD/ PHIL(5), PE, PHILIS(10), TW, PHILUP(35)
      DIMENSION TYM(100), ENCS(100), HRS(100), TS(100),PS(100),
     1          CPMAT(10), TMAT(10)
C1003 FORMAT(1H1,54X,2HBD,I4,5H   RR,I3,7H   CASE,I4//20X,
C     139HAERODYNAMIC HEATING ENVIRONMENT SUMMARY /
C     29X,4HTIME,4X,13HHEAT TRANSFER,4X,8HREC  ERY,6X,5HLOCAL,10X,4HWALL/
C     317X,11HCOEFFICIENT,6X,8HENTHALPY,5X,8HPR  SURE,5X,11HTEMPERATURE /
C     48X,5H(SEC),4X,13H(LBM/FT2-SEC),4X,9H(BTU/LBM),4X,9H(LBF/FT2),6X,
C     57H(DEG F) /)
 2000 FORMAT(1H0, 49X, 29HOPTIMIZATION PROCEDURE RESULT/ 1H0, 8X,
     1         12HAT ITERATION, I3,
     2         35H MAXIMUM WALL TEMPERATURE REACHED =,
     3         F11.3, 34H DEGREES F WITH A SKIN THICKNESS =, E11.5,
     4         8H INCHES./ 1H , 8X, 27HCOMPLETE TRAJECTORY WILL BE,
     5         28H RERUN USING THIS THICKNESS.)
 2500 FORMAT(1H0,  7X, 36HTRAJECTORY WILL BE RERUN WITH A SKIN,
     1        12H THICKNESS =, E11.5)
 3000 FORMAT(1H0, 16X,  37HFAILURE TO OBTAIN CONVERGENCE OF WALL,
     1       47H AND OPTIMUM TEMPERATURES AFTER 10 TRIES.  CASE,
     2       11H ABANDONED.)
 4000 FORMAT(1H0,  5X,22HOPTIMUM TEMPERATURE OF, E11.5,
     1        51H DEGREES F IS GREATER THAN THE MAXIMUM EQUILIBRIUM,
     2       15H TEMPERATURE OF, E11.5,11H DEGREES F./ 1H , 5X,
     3       16H CASE ABANDONED.)
 5000 FORMAT(1H0, 7X, 23HWITH A SKIN THICKNESS =, E11.5, 8H INCHES,,
     1         35H MAXIMUM WALL TEMPERATURE REACHED =, F10.3,
     2         10H DEGREES F/ 1H , 7X, 15HWHICH IS WITHIN, F10.3,
     3         36H PERCENT OF THE OPTIMUM TEMPERATURE.)
 6000 FORMAT(1H0, 48X, 32HOPTIMIZATION - SURPRISING RESULT/
     1        1H0, 13X, 29HWITH INITIAL SKIN THICKNESS =, E11.5,
     2        43H INCHES, MAXIMUM WALL TEMPERATURE REACHED =, F11.4,
     3        11H DEGREES F./ 1H , 12X, 16H WHICH IS WITHIN, F7.3,
     4        51H PERCENT OF THE OPTIMUM TEMPERATURE.  YOUR COMPUTER,
     5        43H CONGRATULATES YOU ON YOUR EXCELLENT GUESS.)
 7000 FORMAT(1H0, 50X, 27HOPTIMIZATION RESULT - RERUN, I3)
 8000 FORMAT(1H0, 7X, 39HOPTIMIZATION PROCEDURE WILL BE REPEATED,
     1         24H TO COMPUTE A NEW GUESS.)
 9000 FORMAT(1H0, 51X, 25HFINAL OPTIMIZATION RESULT)
 9500 FORMAT(1H , 7X, 44HYOUR FRIENDLY NEIGHBORHOOD COMPUTER SUGGESTS/
     1        1H , 12X, 43H(1) LOOSENING YOUR CONVERGENCE CRITERIA, OR/
     2        1H , 12X, 43H(2) IMPROVING, BY WHATEVER MEANS AVAILABLE,,
     3       27H YOUR ORIGINAL LOUSY GUESS.)
C
C       THE FOLLOWING EXECUTABLE STATEMENT  TOPT= TOPT + 459.7
C       WAS REMOVED FROM THE MAIN PROGRAM (HB00) TO THIS SUBROUTINE
C
      TOPT= TOPT + 459.7
      IF (M - 1) 100, 200, 300
C
C
C     SET   THE COUNTER, ERROR FLAG, AND EQUILLIBRIUM TEMPERATURE TO 0.
C
C
  100 N = 0
      TEQMAX = 0.
      ICANT = 0
      RETURN
C
C
C     SAVE FLOWFIELD PARAMETERS AND STORE NEW EQUILLBRIUM TEMPERATURE
C     IF IT EXCEEDS PREVIOUS MAXIMUM.
C
C
  200 N = N + 1
      TYM(N) = TIME
      ENCS(N) = ENC
      HRS(N) = HRECOV
      TS(N) = TW
      PS(N) = PE
      IF (TRE .GT. TEQMAX) TEQMAX = TRE
      RETURN
C
C
```

```
C     IF THE OPTIMUM TEMPERATURE IS LESS THAN THE MAXIMUM
C     EQUILLIBRIUM TEMPERATURE, ABANDON TRY.
C
C
  300 NMAX=N
      IF(M.EQ.4) GO TO 1000
      IF (TOPT .GE. TEQMAX) GO TO 950
C
C
C     DETERMINE MAXIMUM WALL TEMPERATURE REACHED.
C
C
      TMAX =  0.
      DO 400 N = 1, NMAX
      IF (TS(N) .GT. TMAX) TMAX = TS(N)
  400 CONTINUE
      IF (M .EQ. 3) GO TO 850
      ITRY = 0
      ICANT = 0
      DELNEW = DELO
  500 TDIFF = (TMAX - TOPT)/ TOPT
      TDIF2 = (TMAX - TOPT)/(TOPT-TI)
C
C
C     CHECK IF CONVERGENCE HAS BEEN OBTAINED WITH THIS THICKNESS.
C
C
      IF (ABS(TDIFF) .LT. PERCNT) GO TO 700
      IF (IDID .EQ. 2) GO TO 750
      IF (IDID .EQ. 3) GO TO 800
      ITRY = ITRY + 1
      IF (ITRY .GT. 25) GO TO 900
C
C
C     COMPUTE NEW THICKNESS AND GO THROUGH SIMULATED TRAJECTORY TO
C     GET NEW MAXIMUM WALL TEMPERATURE.
C
C
      DELNEW = DELNEW * TDIF2 + DELNEW
      TW = TI
      TMAX = TW
      NM = NMAX - 1
  550 DO 600 N = 1, NM
      TWO = TW
      HW = 0.24 * TW
      QN = ENCS(N) * (HRS(N) - HW) - SIGMA * EMIS * TW**4
      CALL MATRES(MATL, QN, RHOM, CPM, DELNEW, TDOT, TW, TMAT, CPMAT,
     1            NMTL)
      TW = TDOT *  (TYM(N+1) - TYM(N)) + TWO
      IF (TW .GT. TMAX) TMAX = TW
  600 CONTINUE
      GO TO 500
  700 IF (ITRY .EQ. 0) GO TO 860
      TMWR = TMAX - 459.7
      WRITE(6,2000) ITRY, TMWR, DELNEW
      DELO = DELNEW
      RETURN
  750 T1 = TMAX
      D1 = DELNEW
      DELO = DELO + TDIF2* DELO
      GO TO 825
  800 T2 = TMAX
      D2 = DELNEW
      DELO = D2 + (TOPT - T2) * (D2 - D1)/ (T2 - T1)
  825 WRITE(6,2500) DELO
      DELNEW=DELO
      RETURN
C
C
C     IF THIS WAS RE-RUN OF ORIGINAL TRAJECTORY  PRINT RESULTS AND
C     RETURN
C
C
```

```
157:  850 TDIFF = ABS(TMAX - TOPT)/ TOPT
158:      TDCENT = TDIFF * 100.
159:      TMWR = TMAX - 459.7
160:      IF (TDIFF .LE. PERCNT .OR. IDID .GE. 3) GO TO 855
161:      WRITE(6,7000) IDID
162:      WRITE(6,5000) DELNEW, TMWR, TDCENT
163:      WRITE(6,8000)
164:      ICANT = 1
165:      RETURN
166:  855 ICANT = 0
167:      WRITE(6,9000)
168:      WRITE(6,5000) DELNEW, TMWR, TDCENT
169:      IF (TDIFF .GT. PERCNT) WRITE(6,9500)
170:      RETURN
171:  860 TDCENT = ABS(TDIFF) * 100.
172:      TMWR = TMAX - 459.7
173:      WRITE(6,6000) DELO, TMWR, TDCENT
174:      ICANT = -1
175:      RETURN
176:C
177:C
178:C     IF CONVERGENCE HAS NOT BEEN OBTAINED IN 25 TRIES  ABANDON CASE.
179:C
180:C
181:  900 WRITE(6,3000)
182:      ICANT = 1
183:      RETURN
184:C
185:C
186:C     IF OPTIMUM TEMPERATURE IS GREATER THAN MAXIMUM EQUILLIBRIUM
187:C     TEMPERATURE, ABANDON CASE.
188:C
189:C
190:  950 TOWR = TOPT - 459.7
191:      TEQWR = TEQMAX - 459.7
192:      WRITE(6,4000) TOWR, TEQWR
193:      ICANT = 1
194:      RETURN
195:C
196:C     WRITE OUT ENVIRONMENTAL SUMMARY TABLE
197:C
198:1000  CONTINUE
199:C     WRITE(6,1003)(MM(J),J=1,3)
200:      DO 1002 K=1,NMAX
201:      TWF=TS(K)-459.7
202:      WRITE(6,1001) TYM(K),EMCS(K),HRS(K), PS(K), TWF
203: 1001 FORMAT(6X,F8.2,3X,E11.5,6X,F8.2,3X,E11.5,4X,F8.2)
204: 1002 CONTINUE
205:      WRITE(6,1004)
206: 1004 FORMAT(1H1)
207:      RETURN
208:      END
```

```
      SUBROUTINE PCSW(X,Y,ITABLE,OFFTBL,Z)                                  PCSW0001
C*************************************************************************
C
C
C THIS SUBROUTINE COMPUTES PC AND S.W. ANGLE FOR A REAL GAS
C
C*************************************************************************
C
      COMMON/ERRFLG/NERROR
      DIMENSION A(6,6,28) , B(1008)
      EQUIVALENCE (A(1,1,1), B(1))
      OFFTBL=0.
      X3=X
      IF(X.GT. 26.)X=26.                                                    PCSW0015
      IPATCH=0                                                              PCSW0020
      IF( X .LT. 1.) GO TO  500                                             PCSW0025
      IF(Y .LE. 0.) GO TO 510                                               PCSW0030
      IF( Y.GT.60. .AND.((ITABLE.EQ. 2).OR.(ITABLE .EQ.4)))GO TO 520        PCSW0035
      IF ( Y.GT.55. .AND. ((ITABLE .EQ. 1).OR.(ITABLE .EQ. 3)))GO TO 520PCSW0040
      GO TO (10,30,50,70),ITABLE
   10 IF((X.LE. 1.7).AND.(Y.LE.16.))GO TO 101                               PCSW0050
      IF((X.GT. 1.7).AND.(X.LE.2.8).AND.(Y.LE. 32.))GO TO 102               PCSW0055
      IF (X.LE.2.8) GO TO 520                                               PCSW0060
      IF(Y.LE. 16.) GO TO 103                                               PCSW0065
      IF(Y.LE. 35.) GO TO 104                                               PCSW0070
      IF((X.GT. 3.4) .AND. (Y.LE. 45.))GO TO 105                            PCSW0075
      IF (X .GT. 8.) GO TO 106                                              PCSW0080
      GO TO 520                                                             PCSW0085
   30 IF((X.LE. 1.5).AND. (Y.LE. 28.))GO TO 101                             PCSW0090
      IF((X.LE.2.8).AND.(X.GT. 1.5).AND.(Y.LE.48.))GO TO 102                PCSW0095
      IF(X.LE. 2.8)GO TO 520                                                PCSW0100
      IF(Y.LE. 35.)GO TO 103                                                PCSW0105
      GO TO 104                                                             PCSW0110
   50 IF(X.LE. 1.05)GO TO 500                                               PCSW0115
      IF( (X.LE. 1.45).AND. (Y.LE.8.))GO TO 101                             PCSW0120
      IF((X.LE. 2.0) .AND.(X.GT. 1.45).AND.(Y.LE. 20.))GO TO 102            PCSW0125
      IF(X.LE. 2.0) GO TO 520                                               PCSW0130
      IF((X.LE.3.5).AND.(Y .LE. 12.))GO TO 103                              PCSW0135
      IF((X.LE.3.5).AND.(Y.LE. 36.)) GO TO 104                              PCSW0140
      IF(X.LE.3.5) GO TO 520                                                PCSW0145
      IF(Y.LE. 20.)GO TO 105                                                PCSW0150
      IF(Y.LE. 35.)GO TO 106                                                PCSW0155
      GO TO 107                                                             PCSW0160
   70 IF ((X.LE.1.5).AND.(Y.LE.32.)) GO TO 100
      IF(X.LE. 1.5) GO TO 520                                               PCSW0170
      IF((Y.LE.20.).AND.(X.LE.2.8)) GO TO 102                               PCSW0175
      IF((Y.LE.48.).AND.(X.LE.2.8)) GO TO 103                               PCSW0180
      IF(X.LE. 2.8) GO TO 520                                               PCSW0185
      IF(Y.LE. 24.) GO TO 104                                               PCSW0190
      IF(Y.LE. 40.) GO TO 105                                               PCSW0195
      GO TO 106                                                             PCSW0200
  100 C=(X*X-1)*SIN(.0174533*Y)
      G=1.4
      C1=((G+1)*C+2)/((G-1)*C+2)
      C2=ALOG(1.2+1./C)
      Z=(1+C1*C2)*(SIN(.0174533*Y))**2
      RETURN
  101 IPATCH=1                                                              PCSW0205
      GO TO 700                                                             PCSW0210
  102 IPATCH=2                                                              PCSW0215
      GO TO 700                                                             PCSW0220
  103 IPATCH=3                                                              PCSW0225
      GO TO 700                                                             PCSW0230
  104 IPATCH=4                                                              PCSW0235
      GO TO 700                                                             PCSW0240
  105 IPATCH=5                                                              PCSW0245
      GO TO 700                                                             PCSW0250
  106 IPATCH=6                                                              PCSW0255
      GO TO 700                                                             PCSW0260
  107 IPATCH=7                                                              PCSW0265
      IF(X.GT.20.) X=20.
  700 CONTINUE
      IPATAB = 7 * (ITABLE -1) + IPATCH
      Z=0.                                                                  PCSW0275
      X1=1./X                                                               PCSW0280
      DO 740 I=1,6                                                          PCSW0285
      IF (A(1,I,IPATAB) .EQ. 0.) GO TO 760
```

```
      DO 730 J=1,6                                                          PCSW0295
      IF (A(J,I,IPATAB) .EQ. 0.) GO TO 735
      Z = Z + A(J,I,IPATAB) * (X1**(I-1)) * (Y**(J-1))
  730 CONTINUE                                                              PCSW0310
  735 CONTINUE                                                              PCSW0315
  740 CONTINUE                                                              PCSW0320
  760 X=X3
      IF(((ITABLE.EQ.1).OR.(ITABLE.EQ.2)).AND.(Z.GE.90.))OFFTBL=2
      IF((ITABLE .EQ. 3 .OR. ITABLE .EQ.4).AND.Z .GE.1.8)OFFTBL=2
      RETURN
  500 OFFTBL=1.
      RETURN                                                                PCSW0335
  510 WRITE (6,511) Y                                                       PCSW0340
  511 FORMAT(53H0 ****** WEDGE OR CONE ANGLE NEGATIVE OR ZERO,  ANGLE=,     PCSW0345
     1E12.6,9H DEGREES.)
      NERROR=1
      RETURN
  520 OFFTBL=2.
      X=X3
      RETURN                                                                PCSW0365
      DATA (B(I),    I=1, 36) / -.45502295E+3, .4171058E+2,
     1 -.2526002E+1, 3*0., .1954673E+4, -.1441888E+3,
     2.1137163E+2,3*0.,-.261245E+4, .1548773E+3,-.1767171E+2,3*0.,
     3 .1201241E+4,-.4653136E+2, .967671E+1,15*0./
      DATA (B(I),I=37,72)/
     4 .1562248E+2,  -.3610159E+1, -.39188205E-1,  -.2403211E-2,
     5 2*0.,     -.4861156E+2,     .3298564E+2,     -.3057881,
     6    .4272396E-1,     2*0.,     .2316127E+3,     -.7982207E+2,
     7    .1808133E+1,     -.1520378,    2*0.,     -.1535225E+3,
     8    .6332171E+2,    -.2104545E+1,    .16028342,     14*0./
      DATA (B(I),    I=73,108)/
     9 .2105304E-1, .1145824E+1,-.1576662E-2, .4145022E-3, .1464391E-3, PCSW0415
     1-.1168675E-4, .5377458E+2,-.6947946E+1, .1604501E+1,-.33449885  , PCSW0420
     2 .2550358E-1,-.5881141E-3, .2292846E+2, .2210030E+1, .6336085E-2, PCSW0425
     3 .73411788   ,-.7901796E-1, .2022837E-2,-.2833321E+2, .3004077E+2, PCSW0430
     4-.4863306E+1,-.1026703E+1, .14236532   ,-.4066452E-2,12*0./        PCSW0435
      DATA (B(I),    I=109,144)/                .1264253E+3,-.1376618E+2, PCSW0440
     1 .6486186   ,-.1357706E-1, .121729E-3 , .0          ,-.122099E+4 , PCSW0445
     2 .8141611E+2,-.26783191  ,-.3160076E-1, .1795490E-4, .0           , PCSW0450
     3 .5419949E+4,-.9224745E+2,-.1777307E+2, .35320902  , .3728116E-2, PCSW0455
     4 .0          ,-.1302285E+5, .3071897E+3, .7558936E+1, .1641796E+1, PCSW0460
     5-.5539958E-1, .0          , .1368806E+5,-.9949971E+3, .8745465E+2, PCSW0465
     6-.6093441E+1,.1231502,.0,6*0./
      DATA (B(I),I=145,180)/
     7 .3767199E+2,-.3462785E+1, .13918317  ,-.1230641E-2, 2*.0        , PCSW0475
     8 .3208977E+3, .3631055E+2,-.1786110E+1, .1748266E-1, 2*.0        , PCSW0480
     9 .3019779E+4,-.8006098E+3, .2870986E+2,-.25491071  , 2*.0        , PCSW0485
     1 .5964713E+5,-.3507169E+4, .7966175E+2,-.75989497  ,14*.0/       PCSW049
      DATA (B(I),I=181,216)/
     2                          .5636795E+2,-.4826616E+1, .10074503  , PCSW0495
     3 3*.0        ,-.2276700E+4, .3522476E+3,-.6491722E+1, 3*.0        , PCSW0500
     4-.1573135E+6,-.3414515E+3, .8101909E+2, 3*.0        , .4848575E+7, PCSW0505
     5-.1228870E+6, .3798787E+3, 3*.0        ,-.2778084E+7,-.2323070E+6, PCSW0510
     6 .6385858E+4, 9*0./                                               PCSW0515
      DATA (B(I),    I=253,288)/                          -.98543743E+3 , PCSW0520
     1  .14913243E+3 , -.38690958E+1 ,  .78674236E-1 ,  2*.0        ,    PCSW0525
     2  .38645046E+4 , -.57054352E+3 ,  .16057233E+2 , -.38328927   ,    PCSW0530
     3  2*.0         , -.48811490E+4 ,  .72280498E+3 , -.22178436E+2 ,    PCSW0535
     4  .60628930    ,  2*.0         ,  .20911268E+4 , -.30338782E+3 ,    PCSW0540
     5  .10199340E+2 , -.31032062    , 14*.0/
      DATA (B(I),I=289,324)/
     6 -.46935175E+3 ,  .74999131E+1 ,  .62472434    , -.31141753E-2 ,    PCSW0550
     7  .18999426E-3 ,  .0          ,  .39063672E+4 , -.67884265E+2 ,    PCSW0555
     8 -.39509797E+1 ,  .53865644E-2 , -.17998610E-2 ,  .0           ,    PCSW0560
     9 -.11617541E+5 ,  .20852209E+3 ,  .11372642E+2 , -.57256508E-1 ,    PCSW0565
     1  .75608494E-2 ,  .0          ,  .15319342E+5 , -.26893756E+3 ,    PCSW0570
     2 -.16300093E+2 ,  .22614131    , -.14359621E-1 ,  .0           ,    PCSW0575
     3 -.74350930E+4 ,  .12332202E+3 ,  .94192376E+1 , -.23014992    ,    PCSW0580
     4  .10012938E-1 ,7*0./
      DATA                    (B(I),    I=325,360)/       .11409437    ,  PCSW0585
     5  .96082449    ,  .26737328E-1 , -.14371280E-2 ,  .1998871E-4, 0.,PCSW0590
     6  .45937638E+2 , -.90042812E+1 ,  .50227665    , -.84683618E-2 ,    PCSW0595
     7.37723131E-4,0., .13405882E+3 ,  .28456653E+1 ,  .31682443    ,    PCSW0600
     8 -.58037382E-1 ,  .1292204E-2,0.,-.53271055E+3 ,  .10812230E+3 ,    PCSW0605
     9 -.11737956E+2 ,  .56917652,-.93637268E-2,0.,.71874048E+3,
     9-.19760540E+3,
     1       .20371901E+2,-.89913739,.14146178E-1,7*0./                   PCSW0615
```

```
      DATA (B(I),     I=361,396)/          -.61178322E+2,  .61023376E+1 ,  PCSU0620
     1 -.15594696     ,  .19646023E-2 , -.72860442E-5 ,  .0            ,  PCSU0625
     2 -.39856145E+3 ,  .33147091E+2 , -.11340648E+1 ,  .24518360E-1 ,  PCSU0630
     3 -.25084113E-3 ,  .0           , -.40160813E+3 ,  .20795290E+3 ,  PCSU0635
     4 -.78254882E+1 ,  .36634463E-2 ,  .16970589E-2 ,  .0           ,  PCSU0640
     5 -.24399687E+5 ,  .61013951E+3 ,  .73181110E+1 ,  .70631423E-1 ,  PCSU0645
     6 -.63625578E-2 ,  .0           ,  .44471376E+5 , -.81840866E+3 ,  PCSU0650
     7 -.39312454E+2 ,  .67556079    ,  .31871982E-2, 7*0./             PCSU0655
      DATA (B(I),     I=505,540)/          -.3321322       ,  .17676547    ,  PCSU0660
     1  .76334979E-1 , -.28858615E-1 ,  .45590165E-2 ,  .0           ,  PCSU0665
     2 -.17324872    ,  .57850695    , -.42637694    ,  .52397858E-1 ,  PCSU0670
     3 -.38552517E-2 ,  .0           ,  .37217119E+1 , -.21656469E+1 ,  PCSU0675
     4  .55374501    ,  .41198257E-1 , -.10911688E-1 ,  .0           ,  PCSU0680
     5 -.58373798E+1 ,  .14451009E+1 , -.11471143    , -.76328219E-1 ,  PCSU0685
     6  .26758654E-2 ,  .0           ,  .26324790E+1 ,  .10728179    ,  PCSU0690
     7 -.57081032E-1 , -.38821178E-2 ,  .10453250E-1 , 7*0./
      DATA (B(I),
     8I=541,576)/          -.78003525E+1 ,  .13987730E+1 , -.25321884    ,  PCSU0700
     9  .32248734E-1 ,  2*.0          ,  .39695817E+2 , -.37004653E+1 ,  PCSU0705
     1  .16677517    , -.77640998E-1 ,  2*.0          , -.66849856E+2 ,  PCSU0710
     2 -.63689274    ,  .20642351E+1 , -.52601560E-1 ,  2*.0          ,  PCSU0715
     3  .37257988E+2 ,  .50949779E+1 , -.27737575E+1 ,  .15813941,14*0./ PCSU0720
      DATA (B(I),I=577,612)/
     4                                 -.15378365E-2 , -.99252723E-1 ,  PCSU0725
     5  .20554818E-1 , -.94399629E-3 ,  2*.0          ,  .80750904E-2 ,  PCSU0730
     6  .60602619    , -.11797733    ,  .55902406E-2 ,  2*.0          ,  PCSU0735
     7 -.10218554E-1 , -.73096671    ,  .15437942    , -.73038777E-2 ,  PCSU0740
     8 20*0./                                                            PCSU0745
      DATA (B(I),     I=613,648)/          -.18753880E+1 ,  .23500759    ,  PCSU0750
     1 -.72532363E-2 ,  .85816698E-4 ,  2*.0          ,  .10519039E+2 ,  PCSU0755
     2 -.13170006E+1 ,  .46623661E-1 , -.58180164E-3 ,  2*.0          ,  PCSU0760
     3 -.15015365E+2 ,  .20256798E+1 , -.76598607E-1 ,  .11276257E-2 ,  PCSU0765
     4 20*0./
      DATA (B(I),I=649,684)/
     4                                 -.86415987E-4 ,  .64008627E-2 ,  PCSU0770
     5 -.17074787E-2 ,  .34558708E-3 , -.20447315E-4 ,  .39771862E-6 ,  PCSU0775
     6 -.62376658E-2 , -.24418006E-1 ,  .16028931E-1 , -.30534466E-2 ,  PCSU0780
     7  .22400754E-3 , -.50253790E-5 ,  .82195252E-1 ,  .17951074    ,  PCSU0785
     8 -.42795077E-1 ,  .14166802E-1 , -.14439430E-2 ,  .39476380E-4 ,  PCSU0790
     9 -.21585754    ,  .23410848    , -.10090115    , -.92208078E-2 ,  PCSU0795
     1  .23211899E-2 , -.78764006E-4,12*0./
      DATA (B(I),I=685,720)/
     2 -.92395025    ,  .84124699E-1 , -.17560913E-2 ,  .19694004E-4 ,  PCSU0805
     3  2*.0          ,  .13867504E+2 , -.10416866E+1 ,  .22428194E-1 ,  PCSU0810
     4 -.10356036E-3 ,  2*.0          , -.72141665E+2 ,  .52766283E+1 ,  PCSU081
     5 -.10193683    ,  .38163086E-3 ,  2*.0          ,  .10517322E+3 ,  PCSU082
     6 -.68065061E+1 ,  .93235439E-1 ,  .29873349E-3 ,14*0./             PCSU082
      DATA (B(I),     I=721,756)/          -.16903622E+1 ,  .92242116E-1 ,  PCSU0830
     1 -.56681035E-3 , -.20862419E-5 ,  2*.0          ,  .21821198E+2 ,  PCSU083
     2 -.76300746    , -.74202436E-2 ,  .28861086E-3 ,  2*.0          ,  PCSU084
     3  .24459979E+3 , -.15727572E+2 ,  .42597236    , -.41003694E-2 ,  PCSU084
     4  2*.0          , -.13406721E+4 ,  .50227256E+1 ,  .12340818E+1 ,  PCSU0850
     5 -.15132656E-1 ,  2*.0          ,  .77525364E+4 , -.15420909E+3 ,  PCSU085
     6 -.15772325E+1 ,  .16019300E-1 ,  2*.0          ,  .42331760E+3 ,  PCSU086
     7  .56313879E+2 , -.14621209E+2 ,  .32861514    ,  2*.0 /           PCSU0865
      DATA (B(I),     I=757,792)/          .36263253     , -.13370942E-1 ,  PCSU0870
     1 -.25370804E-2 ,  .13539108E-3 ,  .10618352E-4 , -.45418744E-6 ,  PCSU0875
     2 -.13488301E+1 ,  .65415711E-1 ,  .63870986E-2 , -.15324255E-3 ,  PCSU088
     3 -.34125079E-4 ,  .81657254E-6 ,  .16535806E+1 , -.72164580E-1 ,  PCSU088
     4 -.69538967E-2 , -.17346048E-3 , -.20115781E-4 ,  .11946920E-5 ,  PCSU089
     5 -.66820358    ,  .16400213E-1 ,  .78221056E-2 , -.52450415E-3 ,  PCSU089
     6  .67487165E-4 , -.20117242E-5 ,12*0./
      DATA (B(I),I=793,828)/
     7 -.36863924E-2 ,  .28147493E-1 ,  .67341855E-3 , -.89466173E-4 ,  PCSU090
     8  .40145162E-5 , -.28852081E-6 ,  .26601158E-1 , -.17289645    ,  PCSU091
     9  .23900585E-2 , -.38088266E-4 ,  .22862473E-4 ,  .49669006E-6 ,  PCSU091
     1 -.60699902E-1 ,  .35755448    , -.23011052E-3 , -.53449068E-3 ,  PCSU092
     2 -.20972765E-4 , -.12030029E-5 ,  .44010028E-1 , -.244173 47    ,  PCSU092
     3  .51245503E-3 ,  .64123699E-3 , -.98265109E-5 ,  .12896508E-5 ,  PCSU093
     4 12*0./
      DATA  (B(I),     I=829,864)/          .63215967     , -.70699932E-1 ,  PCSU0935
     5  .20580835E-2 ,  .24329582E-4 , -.14960751E-5 ,  .96998447E-8 ,  PCSU0940
     6 -.10601885    , -.32140365E-1 ,  .68815543E-2 , -.12387818E-3 ,  PCSU0945
     7  .11372675E-5 ,  .30261620E-7 ,  .12437513E+1 , -.13636679    ,  PCSU0950
     8  .61878387E-2 , -.45916596E-3 ,  .43365037E-5 , -.60268853E-7 ,  PCSU0955
     9 -.31191903E+1 ,  .31180343    , -.54659903E-2 , -.22863882E-3 ,  PCSU0960
     1  .18861784E-4 , -.16870681E-6 ,12*0./                            PCSU096
```

```
      DATA (B(I),     I=865,900)/        -.29040646E-4 , -.10079196E-3 ,  PCSU0970
     1  .66052545E-3 , -.27032806E-5 ,  .27280690E-7 ,  .0           ,  PCSU0975
     2  .19114071E-1 , -.14227287E-1 ,  .83681549E-3 ,  .87833246E-4 ,  PCSU0980
     3 -.41020549E-5 ,  .0          , -.27024156    ,  .30831374    ,  PCSU0981
     4 -.28020894E-1 , -.18909617E-3 ,  .34049331E-4 ,  .0           ,  PCSU0982
     5  .11520804E+1 , -.11513300E+1 ,  .11562098    ,  .93110585E-3 ,  PCSU0983
     6 -.14726618E-3 ,  .0          , -.14983675E+1 ,  .1132935E+1  ,  PCSU0984
     7 -.78894673E-1 , -.63894080E-2 ,  .30857083E-3 , 7*0./
      DATA (B(I),
     8I=901,936)/       -.11979781E+1 ,  .11290559    , -.27943283E-2 ,  PCSU098
     9  .31188659E-4 ,  2*.0          ,  .82003349E+1 , -.74043705    ,  PCSU098
     1  .22383020E-1 , -.22251180E-3 ,  2*.0          , -.52980660E+1 ,  PCSU098
     2  .18988440     ,  .14978321E-2 , -.67099555E-4 ,  2*.0         ,  PCSU098
     3 -.27328636E+2 ,  .32842271E+1 , -.11826952    ,  .13315012E-2,   PCSU099
     414*0./
      DATA    (B(I),     I=937,972)/       .20051893E+1 , -.10726581    ,  PCSU0991
     5  .25621404E-2 , -.15091504E-4,2*0.,-.1404179E+2, .32816330     ,  PCSU099
     6  .50126398E-2 , -.10986433E-3,2*0.,-.11282539E+3,.10297273E+2 ,  PCSU099
     7 -.28012410     ,  .23418519E-2,2*0.,.65653763E+2,-.63804939E+1 ,  PCSU099
     8  .16344886     , -.11309532E-2 , 14*0./                          PCSU0995
      END                                                               PCSU0996
```

```
      SUBROUTINE PMEXPN(PMANGL,HT,HL,AL,SL,PL,TL,VL,DL,ML,GAMAL)
      DIMENSION F(4,13),G(4,13),A(4,13),ENTH(4,13)
      REAL ML
      COMMON/FLAG/IDEAL
      COMMON/ERRFLG/NERROR
      IF(ML.LT.1.) RETURN
      N=12                                                              PMEX 055
      IF(PMANGL.GT.103.2) GO TO 990
      IF(PMANGL .LE. 86.) N=N-2                                         PMEX 065
      IF(PMANGL .LE. 68.8)  N=N-2                                       PMEX 070
      IF(PMANGL .LE. 51.6) N=N-2                                        PMEX 075
      IF(PMANGL .LE. 34.4) N=N-2                                        PMEX 080
      IF(PMANGL .LE. 17.2) N=N-2                                        PMEX 085
      EN=N                                                              PMEX 090
C
C***** DIVIDE P-M ANGLE INTO INCREMENTS *****
C
      PMANG =PMANGL/57.3
      H=PMANG/EN
      I=1
      J=1
      A(I,J)=AL
      F(I,J)=HT-HL
   10 G(I,J)=2.*F(I,J)*H/SQRT(50103.*F(I,J)/(A(I,J)**2)-1.)
      IF(I.EQ.3) F(4,J)=F(1,J)+G(3,J)
      IF(I.EQ.4) GO TO 30
      IF(I.LT.3) F(I+1,J)=F(1,J)+.5*G(I,J)
      I=I+1
   20 ENTH(I,J)=HT-F(I,J)
      GO TO 40
   30 F(1,J+1)=F(1,J)+(G(1,J)+2.*G(2,J)+2.*G(3,J)+G(4,J))/6.
      I=1
      J=J+1
      GO TO 20
   40 CALL MOLIER(ENTH(I,J),P,3,T,Z,SL,RHO,GAMA)
      IF(IDEAL.GT.0) GO TO 999
      A(I,J)=SQRT(GAMA*1716.48*Z*T)
   90 IF(J.LE.N) GO TO 10
      HL=ENTH(I,J)
      AL=A(I,J)
      VL=SQRT(F(I,J)*50103.)
      PL=P
      DL=RHO
      TL=T
      ML=VL/AL
      GAMAL=GAMA
      GO TO 999
  990 WRITE(6,930) PMANGL
  930 FORMAT(58H0 ***** PRANDTL-MEYER ANGLE GREATER THAN 103.2   PM ANGLPMEX 325
     1E=,E12.6)
      NERROR=1
  999 RETURN
      END
```

```
      SUBROUTINE PMID(PMANGL,MLOCAL,ALOCAL,PLOCAL,TLOCAL,ULOCAL,DLOCAL,
     1MLOCAL)
C
C ***************************************************************************
C
C THIS SUBROUTINE COMPUTES LOCAL CONDITIONS USING THE PRANDTL-MEYER EXPN
C
C ***************************************************************************
C
      REAL MUSTRM,MLOCAL                                                PMID 005
      DIMENSION X(26)                                                   PMID 010
C
C***** SET UP CONSTANT TERMS BEFORE ITERATATION *****
C
      GAMMA=1.4
      MUSTRM=MLOCAL
      IF(MUSTRM.LE.1.)RETURN
      PUSTRM=PLOCAL
      TUSTRM=TLOCAL
      C1=SQRT((GAMMA+1.)/(GAMMA-1.))                                    PMID 015
      C2=PMANGL*.0174533
      C31=SQRT(MUSTRM**2-1.)                                            PMID 025
      C4=C1*ATAN(C31/C1)                                                PMID 035
      C3=ATAN(C31)                                                      PMID 030
      C5=C3-C4-C2
      C6=C1**2                                                          PMID 045
      X(1)=MUSTRM
C
C***** PERFORM NEWTON-RAPHSON ERROR IS LESS THAN ONE PERCENT *****
C
      DO 20 I=2,26                                                      PMID 060
      F=C1*ATAN(X(I-1)/C1)-ATAN(X(I-1))+C5                              PMID 065
      XX=X(I-1)**2                                                      PMID 070
      FPRIME=C6/(C6+XX)-1./(1.+XX)
      X(I)=X(I-1)-F/FPRIME                                              PMID 080
      IF(ABS((X(I)-X(I-1))/X(I-1)) .LE. .01) GO TO 40                   PMID 085
   20 CONTINUE                                                          PMID 090
      GO TO 50                                                          PMID 105
   40 XXX=X(I)                                                          PMID 110
C
C***** COMPUTE LOCAL CONDITIONS *****
C
   50 MLOCAL=SQRT(XXX**2+1.)
      GMINUS=(GAMMA-1.)/2.                                              PMID 120
      C=(1.+GMINUS*MUSTRM**2)/(1.+GMINUS*MLOCAL**2)                     PMID 125
      PLOCAL=PUSTRM*C**(GAMMA/(GAMMA-1.))                               PMID 130
      TLOCAL=TUSTRM*C                                                   PMID 135
      ALOCAL=49.02*SQRT(TLOCAL)
      DLOCAL=PLOCAL/(1716.48*TLOCAL)
      MLOCAL=0.24 *TLOCAL
      ULOCAL=MLOCAL*ALOCAL                                              PMID 150
      RETURN                                                            PMID 160
      END                                                               PMID 170
```

```
      SUBROUTINE PRINT1
C
C
C     THIS SUBROUTINE PRINTS THICK-SKIN SOLUTION RESULTS.
C
C
      COMMON/ THICK/  DTEQ, TDOT, TEQ, QC, QR, HCOUT, EMISS, HREC,
     1 DT,CTIME, PL, DTO, DTI, TEQ2
      COMMON/HANDY/IMAX,DX(25),T(25),MPFLAG(25), NTIWZ,TSYNK,EMISIN,HCIW
     1,TGSF,TIWZ(50),HCIWZ(50),TGASZ(50),TSINKZ(50),TWI,TSINK,TGAS,HCIN,
     2 IFIRST,DELT
      COMMON/ FLWFLD/  PHIL(16), TW,  REST(35)
      DIMENSION TPRINT(25)
      DATA STEVIE/ .4760E-12/
 2000 FORMAT(1H0, 44X, 10HOUTER WALL, 10X, F21.2/
     1       (1H , 44X, I3, 17X, F21.2))
 3000 FORMAT(1H , 44X, 10HINNER WALL, 10X, F21.2)
 4000 FORMAT( 9H HTC(IW)=E11.5,9H T GAS  = F9.2,12H   T SINK  =F9.2,4X,
     17H0 (IW)=E11.5,9H  TEQ IW=F11.2,11H  ST OUTER=E11.5,/103X,
     29HST INNER=E11.5,/52X,
     224HTEMPERATURE DISTRIBUTION  )
      DO 500 I = 1, IMAX
      TPRINT(I) = T(I) - 459.7
  500 CONTINUE
      TWPRNT  = TW - 459.7
      QIN = - EMISIN * STEVIE * TWI ** 4  +  EMISIN * STEVIE * TSINK **
     1 4  +  HCIN * (TGAS - TWI)
      TWIPRT  = TWI - 459.7
      TS = TSINK - 459.7
      TG = TGAS - 459.7
      TEQ2F=TEQ2-459.7
      WRITE(6,4000) HCIN,TG,TS,QIN,TEQ2F,DTO,DTI
      WRITE(6,2000) TWPRNT, (I, TPRINT(I), I = 1, IMAX)
      WRITE(6,3000) TWIPRT
      RETURN
      END
```

```
 1:       SUBROUTINE RADEQT(ENC,HR,EMIS,TW,PE,TRE)
 2:C      CALCULATES RADIATION EQUILIBRIUM TEMPERATURE
 3:       COMMON/FLAG/IDEAL
 4:       SIGMA=4.75892E-13
 5:       TG=TW
 6:     1 CALL MOLIER(HG,PE,2,TG,ZZ,SS,RR,GG)
 7:       IF (IDEAL .EQ. 0) GO TO 10
 8:       HG=.2345*TG+9.786E-6*TG*TG+943.6/TG-1.57
 9:    10 DHDT=.2345+1.9572E-5*TG-943.6/(TG*TG)
10:       IF (TG .LT. 400.) DHDT=.23866
11:       RESID=ENC*(HR-HG)-EMIS*SIGMA*TG**4
12:       IF (ABS(RESID/(ENC*(HR-HG))) .LT. .001) GO TO 30
13:       DERIV=-ENC*DHDT-4.*EMIS*SIGMA*TG*TG*TG
14:       RATE=RESID/DERIV
15:       TG=TG-RATE
16:       GO TO 1
17:    30 TRE=TG
18:       RETURN
19:       END
```

```
      SUBROUTINE SETRUP(TSINK1,FIU1,HCIW1,TGAS1,NTIWZ1,NODES1,
     1 TIWZ1,TGASZ1,TZK1,DX,T11,MPFLAG)
C
C     THIS SUBROUTINE SETS UP THICK SKIN PARAMETERS AND WRITES OUT INPUT
C
      PARAMETER JMAT=14,JMATH=2*JMAT
      DIMENSION MATLF(25),DELM(25)
C
      DIMENSION TIN(25),RHOI.((25),CPIN(25),CONDIN(25),TAGMAT(JMATH)
C
      DIMENSION T11(25),DX(25),MPFLAG(25),RHOZ(25),
     1 CPZ   (25),CONDZ (25),NTAB  ( 5),TIWZ  (50),HCIWZ (50),TIWZ1(50),
     2 TGASZ (50),TSINKZ(50),TGASZ1(50),TZK1(50)
      DIMENSION TABT(10,5),TABCP(10,5),TABCX(10,5)
      DIMENSION TABT1(10),TABT2(10),TABT3(10),TABT4(10),TABT5(10),
     1 TABCP1(10),TABCP2(10),TABCP3(10),TABCP4(10),TABCP5(10),
     2 TABCX1(10),TABCX2(10),TABCX3(10),TABCX4(10),TABCX5(10)
C
C
      COMMON/COMUN/T1,DT1,T2,DT2,T3,DT3,T4,DTCALC,DTEMAX,ATFLAG,HTFLAG,
     1 RN,EL,PARA1,ENL,ENT,PHI,AKL,AKT,PARA2,EMATL,DEL,EMIS,TINC,RHOM,
     2 CPM,TRFLAG,ELFAC,URLFLG,ATRE,GF(6),ALFA(9),HH(3),HFAC,ENTR,
     3 TZ(50),ZZ(50),UZ(50),CFFLG,DSUBO,ELMBDA,UDOT,CORNR,IOPT,CONFLG,
     4 ENT1,TA(10),A1(10),A2(10),A3(10),A4(10),A5(10),A6(10),A7(10),
     5 A8(10),A9(10),NTFAC,OUTPUT,REIRO,REIRIM,LNGPLT,ENUIR,RANFLG,ENT2,
     6 TK1(10),AKL2(10),AKT2(10),TK2(10),ENM3,TMACH(10),AKL3(10),
     7 AKT3(10),HFACT(9),ARIDEF,ALFA0T(50),DELTAT(50),FSPRES(50),
     8 ARIO,ALFA1,AKL2Z1,HSLP1,ALFA2,AKL2Z2,HSLP2,HSLP3,ARIR,ENT3,
     9 TMZ(10),RNZ(10),ELZ(10),PHIZ(10),EMIZ(10),ALFA1R,REFAC1,RSLP1,
     * ALFA2R,REFAC2,RSLP2,RSLP3,ARIT,ALFA1T,ENMTL,TMAT(10),CPMAT(10),
     * PARA11,PSLP1,ALFA2T,PARA12,CPSLP2,PSLP2,PSLP3,ARIC,ALFA1C,CPCPS1,
     * CPSLP1,ALFA2C,CPCPS2,CPSLP3,ENALTZ,FSALT(50),FSTEMP(50),
     * NTAB1,NTAB2,NTAB3,NTAB4,NTAB5,TABT1,TABT2,TABT3,TABT4,TABT5,
     * TABCP1,TABCP2,TABCP3,TABCP4,TABCP5,TABCX1,TABCX2,TABCX3,
     * TABCX4,TABCX5
C
      COMMON/HANDY/NODES,DELM,TIN,MATLF,NTIWZ,TSINK,FIU,HCIW,TGAS,TIWZ,
     1HCIWZ,TGASZ,TSINKZ,TWI,TSNK,TGS,HCIN,IFIRST,DELT
      TSINK=TSINK1
C
      COMMON/PROPS/ RHOZ, CPZ, CONDZ, TABT, TABCP, TABCX,NTAB
C
C
      COMMON/FLWFLD/PHIL(16),TW,REST(35)
C
      DATA TBL,EMAT,CONST1,CONST2/5HTABLE, 4HMATL, 6HCONSTA, 2HNT/
      DATA(TAGMAT(J),J=1,JMATH)/6H2024-T,4H4 AL,6H6AL-4V,4H TI ,6HRENE 4
     1,4H1    ,6HINCO X,4H-750,6HTD NI-,4HCR  ,6HL-605 ,4H    ,6HFS-85 ,
     24HCB  ,6HCARB/C,4HARB ,6HHASTEL,4HLOYX,6HBERYLL,4HIUM ,6HMULLIT,
     34HEHCF,6HFG HNY,4HCORB,6HHRSI/L,4HRSI ,6HSIP+RT,4HU560/
C
      TSINK =TSINK1
```

```
      FIW   =FIW1
      HCIW  =HCIW1
      NTIWZ =NTIWZ1
      NODES =NODES1
C
      DO 75 I=1,50
      TIWZ  (I)=TIWZ1(I)
      TGASZ (I)=TGASZ1(I)
      TSINKZ(I)=TZK1  (I)
C
      IF(I .GT. 25) GO TO 75
C
      MATLF (I)=MPFLAG(I)
   75 CONTINUE
C
      DELT=DT1*DTCALC
      IFIRST=1
      DELM(1)=DX(1)/12.0
      IF(CONFLG.GT..0001) GO TO 101
      TIN(1)=TINC+459.7
      IF(ABS(T11(1)).GT..0001) TIN(1)=T11(1)+459.7
  101 CONTINUE
      MATLF(1)=MPFLAG(1)
      DO 1 N=2,NODES1
      DELM(N)=DX(N)/12.
      IF(DELM(N).LE.0.) DELM(N)=DELM(N-1)
      IF(CONFLG .GT. 0.0001) GO TO 102
      TIN(N)=TINC+459.7
      IF(ABS(T11(N)) .GT. 0.0001) TIN(N)=T11(N)+459.7
  102 CONTINUE
      IF(MATLF(N).EQ.0)  MATLF(N)=MATLF(N-1)
      IF(MATLF(N).GE.100.AND.RHOZ(N).LE.0.)  RHOZ(N)=RHOZ(N-1)
      IF(MATLF(N).EQ.100.AND.CPZ(N).LE.0.) CPZ(N)=CPZ(N-1)
      IF(MATLF(N).EQ.100.AND.CONDZ(N).LE.0.) CONDZ(N)=CONDZ(N-1)
    1 CONTINUE
      WRITE(6,9066) (T11(I), TIN(I), I=1,NODES)
 9066 FORMAT(4F10.0)
C
      TW=TIN(1)
      TWI=TIN(NODES1)
      CALL STOCK(NODES,MATLF,TIN,RHOIN,CPIN,CONDIN)
C
CC
CC    WRITE OUT THICK SKIN PARAMETERS, BEGINNING WITH NODE, MATL INFO
C
      WRITE(6,3) EMIS
    3 FORMAT(/29H THICK SKIN OPTION PARAMETERS //
     *25H   EXTERNAL EMISSIVITY =  F6.4 //
     *36H   NODE AND MATERIAL CHARACTERISTICS //
     *25X,4HNODE,6X,9HTHICKNESS,5X,12HINITIAL TEMP,4X,10HMATL PROPS,6X,
     *37HDENSITY,7X,13HSPECIFIC HEAT,6X,12HCONDUCTIVITY /
     *48X,2HNO.,9X,5H(IN.),10X,7H(DEG F),21X,9H(LBM/FT3),8X,9H(BTU/LBM),
     *55X,18H(BTU/FT-SEC-DEG F))
      DO 4 N=1,NODES1
      DEL=DELM(N)*12.
      TEMPT=TIN(N)-459.7
      IF(MATLF(N)-100)10,15,20
   10 KK=MATLF(N)
```

```
      SUBROUTINE STABLE(FIN, FOUT, GIN, GOUT, QI, TREC)
C*****************************************************************************
C                                                                             *
C          THIS SUBROUTINE ESTABLISHES THE STABLE TIME INCREMENT FOR          *
C          THE THICK SKIN OPTION:  THE LESSER OF THE TIMES REQUIRED FOR       *
C          THE INNER AND OUTER WALLS TO REACH THEIR RESPECTIVE                *
C          RADIATION EQUILIBRIUM TEMPERATURES FOR THE GIVEN NET HEAT          *
C          FLUX AND HEAT CAPACITY.                                            *
C                                                                             *
C          IF THE STABLE TIME INCREMENT IS LESS THAN 1 SECOND BECAUSE          *
C          THE WALL TEMPERATURE AND WALL EQUILIBRIUM TEMPERATURE ARE          *
C          WITHIN 1 DEGREE, THEN THE STABLE TIME INCREMENT IS SET TO 1        *
C          SECOND.                                                            *
C                                                                             *
C*****************************************************************************
      COMMON/ THICK/  DTEQ, TDOT, TEQ, QC, QR, HCO, EMISS, HREC,
     1 DT,CTIME, PL, DTO, DTI, TEQ2
      COMMON/HANDY/IMAX,DX(25),T(25),MPFLAG(25), NTIWZ,TSYNK,EMISIN,HCIW
     1,TGSF,TIWZ(50),HCIWZ(50),TGASZ(50),TSINKZ(50),TWI,TSINK,TGAS,HCIN,
     2 IFIRST,DELT
      COMMON/ERRFLG/MERROR
      DATA STEVIE/ .4760E-12/
 3000 FORMAT(1H0, 13X, 36H***NEWTON-RAPHSON FAILED TO CONVERGE,
     1       53H ON A VALUE FOR THE INNER EQUILIBRIUM TEMPERATURE AT,
     2       F10.3, 11H SECONDS***)
C*****************************************************************************
C                                                                             *
C          STABLE TIME INCREMENT:  OUTER WALL                                 *
C                                                                             *
C*****************************************************************************
      CALL RADEQT(HCO,HREC,EMISS,T(1),PL,TEQ)
      QO = QC - QR
      DTO = ABS(GOUT * (TEQ  - T(1))/(QO - FOUT *GOUT* (T(1) - T(2))))
      IF(DTO.LT.1..AND.(ABS(TEQ-T(1))).LT.1.) DTO =1.0
C*****************************************************************************
C                                                                             *
C          STABLE TIME INCREMENT:  INNER WALL                                 *
C                                                                             *
C            FOR ADIABATIC INNER WALL, SET RADIATION VIEW FACTOR AND          *
C            HEAT TRANSFER COEFFICIENT EQUAL TO ZERO.                         *
C                                                                             *
C*****************************************************************************
      IF (EMISIN .NE. 0. .OR. HCIN .NE. 0.) GO TO 10
        DTI = 1.0E+06
        TEQ2 = 0.
        GO TO 20
   10 CONTINUE
      TEQ2 = T(IMAX)
      AEQ2 = EMISIN * STEVIE
      BEQ2 = HCIN
      CEQ2 = AEQ2 * TSINK**4 + HCIN* TGAS
C*****************************************************************************
C                                                                             *
C            FOR INNER WALL, IF SUM OF RADIATIVE AND CONVECTIVE HEAT          *
C            FLUX IS ZERO, SET RADIATION EQUILIBRIUM TEMPERATURE TO           *
C            -459.7 F.                                                        *
C                                                                             *
C*****************************************************************************
      IF (CEQ2 .EQ. 0.) TEQ2 = 0.
C*****************************************************************************
C                                                                             *
C            THE NEWTON-RAPHSON METHOD IS USED TO SOLVE FOR THE               *
C            RADIATION EQUILIBRIUM TEMPERATURE.                               *
C                                                                             *
C*****************************************************************************
      IF (CEQ2 .NE. 0.) CALL NEWT(AEQ2, BEQ2, CEQ2, TEQ2, ICANT)
      IF (ICANT .NE. 0) GO TO 910
      DTI = ABS(GIN*(T(IMAX)-TEQ2)/(FIN*GIN*(T(IMAX-1)-T(IMAX))+QI))
      IF(DTI.LT.1..AND.(ABS(TEQ2-T(IMAX))).LT.1.) DTI=1.0
   20 CONTINUE
      DTEQ = AMIN1(DTO,DTI)
      RETURN
  910 WRITE(6,3000) CTIME
      MERROR=1
      RETURN
      END
```

```
      SUBROUTINE STOCK(N,MATLN,TN,RHON,CPN,CONDN)
C
C     PROVIDES THERMAL PROPERTIES FOR THICK SKIN CONDUCTION SOLUTION
C
      DIMENSION MATLN(25),TN(25),RHON(25),CONDN(25), RHOZ(25), CPZ(25),
     1CONDZ(25), TABT(10,5), TABCP(10,5), TABCX(10,5), NTAB(5),CPN(25)
      COMMON/PROPS/ RHOZ, CPZ, CONDZ, TABT, TABCP, TABCX,NTAB
    1 DO 100 K=1,N
      IF(MATLN(K)-100) 30,20,10
   10 J= MATLN(K)-100
      RHON(K)=RHOZ(K)
      T=TN(K)-459.7
      CALL TBLIN(T     ,TABT(1,J),CPN(K),TABCP(1,J),CONDN(K),TABCX(1,J),
     1NTAB(J))
      GO TO 100
   20 RHON(K)=RHOZ(K)
      CPN(K)=CPZ(K)
      CONDN(K)=CONDZ(K)
      GO TO 100
   30 CALL MPROPS(MATLN(K),TN(K),RHON(K), CPN(K), CONDN(K))
  100 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE STORED(TIME,NHFLAG,ARIDEF,ATRE,ZZ,VZ,ALFA0T,
     1 DELTAT,ITHICK,LNGPLT,MAXTME,ITINIT)
C
C     DECLARATIVE STATEMENTS
C
      INTEGER BDYPNT,TRANME
      PARAMETER J1=17, J2=500, J3=32
      DIMENSION TIME1(J2),XME1(J2),REL1(J2),QC1(J2),QC1T(J2),
     $TREF1(J2),TW1(J2),PE1(J2),CP1(J2),BETA1(J2),ALPHA1(J2),AKLZ1(J2),
     $ HFACZ1(J2),QT(2),TT(2),TW2(J2)
      DIMENSION VZ(50),TZ(50),ALFA0T(50),ZZ(50),DELTAT(50)
      DIMENSION BDYPNT(4),TRANME(6),IBUF(200),LABEL(20,6),IPAK(40)
C
C
C
      COMMON/LABS/LABEL
      COMMON/DIBUJO/BDYPNT,TRANME,ICASE
      COMMON/AXDAT/XOR,XSTEP,XAXIS
      COMMON/ARRAY/QC1,TIME1,BETA1,ALPHA1,AKLZ1,
     $HFACZ1,XME1,REL1,PE1,CP1,TW1,TREF1,QT,TT,TW2,QC1T
      COMMON/MAX/QM,BETAM,AKLZM,HFACZM,PEM,CPPM,TREFM
      COMMON/PLOTT/JRCD,IT,NT,NT2,NFF,PCT
      COMMON IPT,IBUF,IPAK
C
      WRITE(9,200)ITINIT, ICASE,LNGPLT,NHFLAG,ITHICK,ARIDEF,ATRE
      WRITE(9,220)(BDYPNT(I),I=1,4),(TRANME(I),I=1,6),ICASE,NT,IT
    5 CONTINUE
C
      IF(ICASE .GT. 5) GO TO 35
      IF(ICASE .GT. 3) GO TO 30
      GO TO (10,20,30), ICASE
C
C      BASIC PLOT DATA
C
   10 CONTINUE
      WRITE(9,230) (TZ(I),ZZ(I),VZ(I),ALFA0T(I),I=1,NT)
      GO TO 40
C
C      CASE 2 DATA
C
   20 CONTINUE
      WRITE(9,240) (TIME1(I),QC1(I),QC1T(I),I=1,IT)
      GO TO 40
C
C
C
   30 CONTINUE
      WRITE(9,240)(TIME1(I),AKLZ1(I),HFACZ1(I),XME1(I),REL1(I),
     1      I),CP1(I),QC1(I),TREF1(I),TW1(I),TW2(I),
     2 I=1,IT)
      WRITE(9,240) (DELTAT(I),I=1,NT)
      GO TO 40
   35 CONTINUE
      WRITE(9,230) (TZ(I),ZZ(I),VZ(I),ALFA0T(I),I=1,NT)
C
      WRITE(9,240)(TIME1(I),AKLZ1(I),HFACZ1(I),XME1(I),REL1(I),
     1 PE1(I),CP1(I),QC1(I),TREF1(I),TW1(I),TW2(I),
     2 I=1,IT)
      WRITE(9,240) (DELTAT(I),I=1,NT)
  200 FORMAT(5I5,2F10.2)
  210 FORMAT(6A6)
  220 FORMAT(4A6,1X,6A6,1X,3I5)
  230 FORMAT(8F10.0)
  240 FORMAT(6E12.5)
   40 CONTINUE
C
      RETURN
      END
```

```
      SUBROUTINE SWCYL2(RN,PHI,ENCL,ENCT)
      COMMON/FLWFLD/TINF,PINF,RHOINF,AINF,RHOE,PE,TE,HE,XMUE,UE,RHOO,PO,
     1TO,HO,XMUO,RHOW,TW,HW,XMUW,RHOS,TS,HS,XMUS,RHOR,TR,HR,XMUR,U,XME
     2,REL,HINF,XMUINF,PR,PU,DU,TU,XMUU,XMACHU,VU,HU, ALPHA,
     3RHOSTL,HSTL,TSTL,XMUSTL,RHOSTT,HSTT,TSTT,XMUSTT,HRECL,HRECT,S
     *,GINF,GAMAU,GAMAS,GAMAE,GAMAO,GW,GAMAG,PRL,PRT
      COMMON/CYL/ HSL,PSL,RHOSL,XMUSL,TSL,USL
      COMMON/STAG/PSTAG,RHOSTG,TSTG,XMUSTG
      COMMON/ERRFLG/NERROR
      COMMON/FLAG/ IDEAL
      RED=DU*VU*2.*RN/XMUU
      REL=RED
    1 PSV=PO
      XSV=XMUO
      RSV=RHOO
      TSV=TO
      RWSV=RHOW
      XMUWSV=XMUW
      PO=PSTAG
      RHOO=RHOSTG
      XMUO=XMUSTG
      TO=TSTG
      CALL MOLIER(HW,PO,0,TX,ZX,SX,RHOW,GX)
      CALL HANSEN(XMUW,PO,TW)
      CALL FAYRID(RN,ENF)
      PRL=.71
      PRT=.71
      PO=PSV
      RHOO=RSV
      XMUO=XSV
      TO=TSV
      RHOW=RWSV
      XMUW=XMUWSV
      ENCL=0.707*ENF*COS(PHI*.0174)**1.1
   10 DUDX=SQRT(2.*(PSL-PU)/RHOSL)/RN
      RMR=RHOSTT*XMUSTT/(RHOO*XMUO)
      ENCT=1.04*RHOO**.8*XMUO**.2*USL**.6*RMR**.8*DUDX**.2/PRT**.667
      S=PRL**.667
   99 RETURN
      END
```

```
      SUBROUTINE TRANS(ENCL,ENCT,PARA1,PARA2,PARA,TIME,ENC,HRECOV,NTR,
     *PCT,TRFLAG,EL,ELFAC,ENL,ELL,NCFLG,VX,AKLZ,ITRAN,M)
      DIMENSION EMEX(7),RETRX(7),REEX(6),ELX(6),XX(10),M(4)
      COMMON/FLWFLD/TINF,PINF,RHOINF,AINF,RHOE,PE,TE,ME,XMUE,UE,RHOO,PO,
     1TO,HO,XMUO,RHOU,TU,HU,XMUU,RHOS,TS,HS,XMUS,RHOR,TR,HR,XMUR,U,XME
     2,REL,HINF,XMUINF,PR,PU,DU,TU,XMUU,XMACHU,UU,HU, ALPHA,
     3RHOSTL,HSTL,TSTL,XMUSTL,RHOSTT,HSTT,TSTT,XMUSTT,HRECL,HRECT,S
     *,GINF,GAMAU,GAMAS,GAMAE,GAMAO,GU,GAMAG,PRL,PRT
      COMMON/NFLAG/NHFLAG
      COMMON/ERRFLG/ NERROR
      DATA(REEX(K),K=1,6)/ 5.,6.518,6.778,7.,7.301,10./,NX/6/
      DATA (ELX(K),K=1,6)/ 5.64,2.,1.702,1.605,1.535,1.535/
      DATA (EMEX(K),K=1,7)/0.5,1.0,1.5,2.0,3.5,4.5,5.5 /
      DATA (RETRX(K),K=1,7)/ 5.30103,5.54407,5.81291,6.0,6.0,6.07918,
     1 6.25527/
      DATA NX2/7/
C
C     TRFLAG=1     TRANSITION FROM  TIME1 TO TIME 2 , LAMINAR TO TURB.
C     TRFLAG=2     TRANSITION FROM  TIME1 TO TIME 2 , TURBULENT TO LAM.
C     TRFLAG=3     TRANSITION FROM  REL1 TO REL2
C     TRFLAG=4     TRANSITION FROM  RETHETA1 TO RETHETA2
C     TRFLAG=5     TRANSITION FROM  ED PARAM 1  TO  ED PARAM 2
C     TRFLAG=6     TRANSITION BASED ON E.D.TRANS. LENGTH AND ALPHA
C     TRFLAG=7     TRANSITION BASED ON NAR CRITERIA RETR=F(ME)
C     TRFLAG=8     TRANSITION BASED ON R.I. CRITERION --- RETHETA/ML
C
      NERROR=0
      ITRAN=0
      IF(NHFLAG.EQ.1) GO TO 400
C
C
    1 NFLAG=TRFLAG+.001
      IF(NFLAG.EQ.0) GO TO 30
      IF(NFLAG-2)10,20,2
    2 IF(NFLAG-4)30,40,3
    3 IF(NFLAG-6) 40,60,4
    4 IF(NFLAG-8) 70,80,997
C
C     TIME DEPENDANT TRANSITION - LAMINAR TO TURBULENT
C
   10 IF(TIME-PARA1)100,100,11
   11 IF(TIME-PARA2)12,300,300
   12 PCT=(TIME-PARA1)/(PARA2-PARA1)
      GO TO 200
C
C     TIME DEPENDANT TRANSITION - TURBULENT TO LAMINAR
C
   20 IF(TIME-PARA1)300,300,21
   21 IF(TIME-PARA2)22,100,100
   22 PCT=(PARA2-TIME)/(PARA2-PARA1)
      GO TO 200
C
C     TRANSITION FROM RE SUB L 1  TO RE SUB L 2
C
   30 IF(PARA1.GT.PARA2)GO TO 33
      IF(REL-PARA1)100,100,31
   31 IF(REL-PARA2)32,300,300
```

```
   32 PCT=(REL-PARA1)/(PARA2-PARA1)
C
C          THE FOLLOWING EXPRESSION IS USED TO MATCH THE RI TRANSITION ZONE
C
      PCT=(SIN((REL-PARA1)/(PARA2-PARA1)*1.570796))**2                    RI
      GO TO 200
   33 IF(REL-PARA2)100,100,34
   34 IF(REL-PARA1)35,300,300
   35 PCT=(REL -PARA2)/(PARA1-PARA2)
      PCT=(SIN((REL-PARA1)/(PARA2-PARA1)*1.570796))**2                    RI
      GO TO 200
C
C     TRANSITION FROM RE THETA1 TO RE THETA 2 (BASED ON ECKERT LAM.PROPS
C
   40 RETHET=0.664*SQRT(RHOSTL*XMUSTL*REL/(RHOE*XMUE*EML))
      IF(NFLAG.EQ.5)GO TO 50
      PARA=RETHET
      IF(PARA1.GT.PARA2) GO TO 46
      IF(RETHET-PARA1)100,100,44
   44 IF(RETHET-PARA2)45,300,300
   45 PCT=(RETHET-PARA1)/(PARA2-PARA1)
      GO TO 200
   46 IF(RETHET-PARA2)100,100,47
   47 IF(RETHET-PARA1)48,300,300
   48 PCT=(RETHET-PARA2)/(PARA1-PARA2)
      GO TO 200
C
C     TRANSITION FROM ED PARAMETER 1 TO ED PARAMETER 2
C
   50 PARA=RETHET/(XME*(RHOE*UE/XMUE)**.2)
      IF(PARA-PARA1)100,100,51
   51 IF(PARA-PARA2)52,300,300
   52 PCT=(PARA-PARA1)/(PARA2-PARA1)
      GO TO 200
C
C     TRANSITION OCCURS WHEN L IS GREATER THAN E.D.TRANSITION LENGTH
C
   60 CALL EDPARM(ALPHA,PARAM)
      ELTRAN=2.26*(PARAM*PARAM*XME*XME)*RHOE**.4*XMUE**1.6/(RHOSTL
     1*XMUSTL*UE**.6)*EML
      IF(NCFLG.LE.0) GO TO 65
      IF(NCFLG.GT.2) GO TO 67
      IF(ELTRAN.GT.(UX/2.)) GO TO 66
      ELTRAN=-.5*UX*ALOG(1.-2.*ELTRAN/UX)
      GO TO 65
   67 ELTRAN=ELTRAN*EL/ELL
      GO TO 65
   66 ELTRAN=ELTRAN*1000.
   65 PARA=ELTRAN
      IF(ELFAC.GE.1.) GO TO 63
      RELOG=ALOG10(RHOE*UE*ELTRAN/XMUE)
      CALL TBLIN(RELOG,REEX,ELFAX,ELX,X,XX,NX)
      ELT2=ELFAX*ELTRAN
      GO TO 64
   63 ELT2=ELFAC*ELTRAN
   64 CONTINUE
      PARA1=ELTRAN
      PARA2=ELT2
```

```
      IF(EL -ELTRAN)100,100,61
   61 IF(EL -ELT2) 62,300,300
   62 PCT=(EL -ELTRAN)/(ELT2-ELTRAN)
      GO TO 200
C
C     TRANSITION OCCURS WHEN L IS GREATER THAN TRANS LENGTH =F(RE(ME))
C
   70 CALL TBLIN(XME,EMEX,RELG,RETRX,X,XX,NX2)
      ELTRAN=(10.**RELG)*XMUE/(RHOE*UE)
      PARA=ELTRAN
      IF(ELFAC.GE.1.) GO TO 73
      RELOG=ALOG10(RHOE*UE*ELTRAN/XMUE)
      CALL TBLIN(RELOG,REEX,ELFAX,ELX,X,XX,NX)
      ELT2=ELFAX*ELTRAN
      GO TO 74
   73 ELT2=ELFAC*ELTRAN
   74 CONTINUE
      PARA1=ELTRAN
      PARA2=ELT2
      IF(EL -ELTRAN)100,100,71
   71 IF(EL -ELT2) 72,300,300
   72 PCT=(EL -ELTRAN)/(ELT2-ELTRAN)
      GO TO 200
C
C          R.I. TRANSITION CRITERION --- RE THETA/MACH NO.
C          -TRANSITION IS INITIATED AT AN RE THETA/MACH NO.(ALPHA)
C          -FLOW IS FULLY TURBULENT AT AN RE X WHICH IS EQUAL TO 2X THE
C           RE X DERIVED FROM THE RE THETA/MACH NO.(ALPHA) PARAMETER
C           EVALUATED AT THAT TIME
C
   80 IF (PARA .LT. PARA1) GO TO 100
      IF (NTR .EQ. 1)
     *PARA1T=(PARA1*XME*AKLZ/.664)**2*ENL*RHOE*XMUE/RHOSTL/XMUSTL
      ZONE=2.0
      IF (M(2) .EQ. 16) ZONE=1.6
      IF (M(2) .EQ. 17) ZONE=1.325
      IF (M(2) .EQ. 18) ZONE=1.6
      PARA2=ZONE*(PARA1*XME*AKLZ/.664)**2*ENL*RHOE*XMUE/RHOSTL/XMUSTL
      PARA=REL
      IF (PARA .GE. PARA2) GO TO 300
      PCT=(SIN((PARA-PARA1T)/(PARA2-PARA1T)*1.570796))**2
      GO TO 200
C
C     LAMINAR FLOW
C
  100 ENC=ENCL
      HRECOV=HRECL
      RHOS=RHOSTL
      HS=HSTL
      TS=TSTL
      XMUS=XMUSTL
      PCT=0.
      PR=PRL
C
C          ITRAN  IS A FLAG TO INDICATE POINT OF LAMINAR/TRANSITION OR
C                 TRANSITION/TURBULENT FLOW FOR PRINTOUT AND PLOTTING.
C                 IT IS RESET TO ZERO WITH EACH PASS THROUGH THIS SUBROUTINE.
C                 ITRAN=0      NO CHANGE IN TYPE OF FLOW
```

```
174:C                   ITRAN=1     CHANGE IN TYPE OF FLOW
175:C
176:C           NTR     IS A FLAG TO INDICATE THE TYPE OF FLOW.  IT IS USED TO
177:C                   DETERMINE THE VALUE OF ITRAN.
178:C                   NTR=1       LAMINAR
179:C                   NTR=2       TRANSITIONAL
180:C                   NTR=3       TURBULENT
181:C
182:        IF (NTR .EQ. 2) ITRAN=1
183:        NTR=1
184:        GO TO 999
185:C
186:C       TRANSITIONAL FLOW
187:C
188:   200  ENC=(1.-PCT)*ENCL+PCT*ENCT
189:        HRECOV=(1.-PCT)*HRECL+PCT*HRECT
190:        PR=(1.-PCT)*PRL+PCT*PRT
191:        RHOS=RHOSTL
192:        HS=HSTL
193:        TS=TSTL
194:        XMUS=XMUSTL
195:        IF (NTR .EQ. 1) ITRAN=1
196:        IF (NTR .EQ. 3) ITRAN=1
197:        NTR=2
198:        GO TO 999
199:C
200:C       TURBULENT FLOW
201:C
202:   300  ENC=ENCT
203:        HRECOV=HRECT
204:        RHOS=RHOSTT
205:        HS=HSTT
206:        TS=TSTT
207:        XMUS=XMUSTT
208:        PR=PRT
209:        IF (NTR .EQ. 2) ITRAN=1
210:        NTR=3
211:        PCT=1.
212:        GO TO 999
213:C
214:C       STAGNATION POINT
215:C
216:   400  ENC=ENCL
217:        HRECOV=HO
218:        NTR=1
219:        PCT=0.
220:        ENCT=0.
221:        PR=PRL
222:        GO TO 999
223:C       RETURN
224:C
225:C
226:   997  WRITE(6,998)NFLAG
227:   998  FORMAT(/20H TRANSITION FLAG NO.,I3,19H DOES NOT YET EXIST/)
228:        NERROR=1
229:   999  RETURN
230:        END
```

```
      SUBROUTINE TBLIN(X,XX,Y,YY,Z,ZZ,N)
C
C     LINEAR INTERPOLATION SUBROUTINE  (INCREASING INDEP. VARIABLE)
C
      DIMENSION XX(N), YY(N), ZZ(N)
      NA=N-1
      IF(X-XX(1)) 1,2,2
    1 Y=YY(1)
      Z=ZZ(1)
      GO TO 10
    2 DO 6  K=1,NA
      IF(X-XX(K+1))4,3,6
    3 RATIO=1.
      GO TO 5
    4 RATIO=(X-XX(K))/(XX(K+1)-XX(K))
    5 Y=YY(K)+RATIO*(YY(K+1)-YY(K))
      Z=ZZ(K)+RATIO*(ZZ(K+1)-ZZ(K))
      GO TO 10
    6 CONTINUE
      Y=YY(N)
      Z=ZZ(N)
   10 RETURN
      END
```

```
      SUBROUTINE TINT6(A,AT,B,BT,C,CT,D,DT,E,ET,F,FT,G,GT,IL,MAX)
C   LINEAR INTERPOLATION FOR 6 VARIABLES - IF IL=1,THE INDEPENDENT
C   VARIABLE IS DECREASING
      DIMENSION AT(10),BT(10),CT(10),DT(10),ET(10),FT(10),GT(10)
      IF(IL) 1,1,10
1     IF(A-AT(1))2,3,4
2     B=.222E+30
      RETURN
3     B=BT(1)
      C=CT(1)
      D=DT(1)
      E=ET(1)
      F=FT(1)
      G=GT(1)
      RETURN
10    IF(AT(1)-A)2,3,11
4     DO 9 I=2,MAX
      IF(A-AT(I))20,18,9
9     CONTINUE
      GO TO 2
18    B=BT(I)
      C=CT(I)
      D=DT(I)
      E=ET(I)
      F=FT(I)
      G=GT(I)
      RETURN
20    RATIO=(A-AT(I-1))/(AT(I)-AT(I-1))
      B=BT(I-1) + RATIO*(BT(I)-BT(I-1))
      C=CT(I-1) + RATIO*(CT(I)-CT(I-1))
      D=DT(I-1) + RATIO*(DT(I)-DT(I-1))
      E=ET(I-1) + RATIO*(ET(I)-ET(I-1))
      F=FT(I-1) + RATIO*(FT(I)-FT(I-1))
      G=GT(I-1) + RATIO*(GT(I)-GT(I-1))
      RETURN
11    DO 16 I=2,MAX
      IF(AT(I)-A)20,18,16
16    CONTINUE
      GO TO 2
      END
```

```
      SUBROUTINE VRUNL(TRFLAG,ELTRAN,ELL,ELT,ELTP,PARA1,PARA2,ENL,EL,VX,
     1 NCFLG)
      DIMENSION EMEX(7),RETRX(7),XX(7)
      COMMON/FLWFLD/TINF,PINF,RHOINF,AINF,RHOE,PE,TE,HE,XMUE,UE,RHOO,PO,
     1TO,HO,XMUO,RHOW,TW,HW,XMUW,RHOS,TS,HS,XMUS,RHOR,TR,HR,XMUR,U,XME
     2,REL,HINF,XMUINF,PR,PU,DU,TU,XMUU,XMACHU,VU,HU, ALPHA,
     3RHOSTL,HSTL,TSTL,XMUSTL,RHOSTT,HSTT,TSTT,XMUSTT,HRECL,HRECT,S
     4,GINF,GAMAU,GAMAS,GAMAE,GAMAO,GW,GAMAG,PRL,PRT
      DATA (EMEX(K),K=1,7)/0.5,1.0,1.5,2.0,3.5,4.5,5.5 /
      DATA (RETRX(K),K=1,7)/ 5.30103,5.54407,5.81291,6.0,6.0,6.07918,
     1 6.25527/
      DATA NX2/7/
      NTRANS=TRFLAG+.001
      IF(NTRANS.EQ.6) GO TO 60
      IF(NTRANS.GT.6) GO TO 70
      PARA=PARA1
      IF(PARA2.LT.PARA1) PARA=PARA2
      IF(NTRANS-4)30,40,50
   30 ELTRAN=PARA*XMUE/(RHOE*UE)
      GO TO 100
   40 ELTRAN=(PARA*XMUE/.664)**2/(RHOSTL*XMUSTL*UE)
      GO TO 100
   50 ELTRAN=2.26*PARA*PARA*XME*XME*RHOE**.4*XMUE**1.6/(RHOSTL*XMUSTL*
     1UE**.6)*ENL
      IF(NCFLG.LE.0) GO TO 100
      IF(NCFLG.LT.3) GO TO 51
      ELTRAN=ELTRAN*EL/ELL
      GO TO 100
   51 IF(ELTRAN.GT.(VX/2.)) GO TO 52
      ELTRAN=-.5*VX*ALOG(1.-2.*ELTRAN/VX)
      GO TO 100
   52 ELTRAN=1000.*ELTRAN
      GO TO 100
   60 CALL EDPARM(ALPHA,PARA)
      GO TO 50
   70 CALL TBLIN(XME,EMEX,RELG,RETRX,X,XX,NX2)
      ELTRAN=(10.**RELG)*XMUE/(RHOE*UE)
  100 ELTP=ELT
      IF(EL  .LT.ELTRAN) GO TO 999
      IF(NCFLG.LE.0) GO TO 110
      ELT=(EL-ELTRAN)*ELT/EL
      GO TO 999
  110 ELT=ELTP-ELTRAN
  999 RETURN
      END
```

```
      SUBROUTINE WRINP(NODES,NFF)
      PARAMETER JMAT=14,JMATH=2*(1+JMAT)
      DIMENSION TAGMAT(JMATH)
      DIMENSION T(25) ,DX    (25),MPFLAG  (25),RHOZ  (25),
     1 CPZ   (25),CONDZ (25),NTAB  ( 5),TIWZ  (50),HCIWZ (50),
     2 TGASZ(50), TSINKZ(50)
      DIMENSION TABT(10,5),TABCP(10,5),TABCX(10,5)
C
      COMMON/COMUN/T1,DT1,T2,DT2,T3,DT3,T4,DTCALC,DTEMAX,ATFLAG,HTFLAG,
     1 RN,EL,PARA1,ENL,ENT,PHI,AKL,AKT,PARA2,EMATL,DEL,EMIS,TIN,RHOM,
     2 CPM,TRFLAG,ELFAC,VRLFLG,ATRE,GF(6),ALFA(9),HH(3),HFAC,ENTR,
     3 TZ(50),ZZ(50),VZ(50),CFFLG,DSUBO,ELMBDA,UDOT,CORNR,IOPT,CONFLG,
     4 ENT1,TA(10),A1(10),A2(10),A3(10),A4(10),A5(10),A6(10),A7(10),
     5 A8(10),A9(10),NTFAC,OUTPUT,REIRO,REIRIM,LNGPLT,ENVIR,RANFLG,ENT2,
     6 TK1(10),AKL2(10),AKT2(10),TK2(10),ENM3,TMACH(10),AKL3(10),
     7 AKT3(10),HFACT(9),ARIDEF,ALFA0T(50),DELTAT(50),FSPRES(50),
     8 ARIQ,ALFA1,AKL2Z1,HSLP1,ALFA2,AKL2Z2,HSLP2,HSLP3,ARIR,ENT3,
     9 TMZ(10),RMZ(10),ELZ(10),PHIZ(10),EMIZ(10),ALFA1R,REFAC1,RSLP1,
     * ALFA2R,REFAC2,RSLP2,RSLP3,ARIT,ALFA1T,ENMTL,TMAT(10),CPMAT(10),
     * PARA11,PSLP1,ALFA2T,PARA12,CPSLP2,PSLP2,PSLP3,ARIC,ALFA1C,CPCPS1,
     * CPSLP1,ALFA2C,CPCPS2,CPSLP3,ENALTZ,FSALT(50),FSTEMP(50),
     * NTAB1,NTAB2,NTAB3,NTAB4,NTAB5,TABT1,TABT2,TABT3,TABT4,TABT5,
     * TABCP1,TABCP2,TABCP3,TABCP4,TABCP5,TABCX1,TABCX2,TABCX3,
     * TABCX4,TABCX5
C
      COMMON/PROPS/ RHOZ, CPZ, CONDZ, TABT, TABCP, TABCX,NTAB
      COMMON/FLWFLD/TINF,PINF,RHOINF,AINF,RHOE,PE,TE,HE,XMUE,UE,RHOO,PO,
     1TO,HO,XMUO,RHOW,TW,HW,XMUW,RHOS,TS,HS,XMUS,RHOR,TR,HR,XMUR,U,XME
     2,REL,HINF,XMUINF,PR,PU,DU,TU,XMUU,XMACHU,UU,HU, ALPHA,
     3RHOSTL,HSTL,TSTL,XMUSTL,RHOSTT,HSTT,TSTT,XMUSTT,HRECL,HRECT,S
     *,GINF,GAMAU,GAMAS,GAMAE,GAMAO,GW,GAMAG,PRL,PRT
      COMMON/OPTT/                TOPT,PERCNT,DELO,TI,
     1              SIGMA, EMMY, MATLF, NMTL, ROOM, CMM, ICANT, ITRIED
      COMMON/HANDY/IMAX,DX,T,MPFLAG, NTIWZ,TSYNK,EMISIN,HCIW
     1,TGSF,TIWZ,HCIWZ,TGASZ,TSINKZ,TWI,TSINK,TGAS,HCIN,
     2 IFIRST,DELT
      DATA(TAGMAT(J),J=1,JMATH)/6H      ,4H    ,6H2024-T,4H4 AL,6H6AL-4V
     * ,4H TI ,6HRENE 4,
     1 4H1   ,6HINCO X,4H-750,6HTD NI-,4HCR  ,6HL-605 ,4H    ,6HFS-85 ,
     24HCB  ,6HCARB/C,4HARB ,6HHASTEL,4HLOYX,6HBERYLL,4HIUM ,6HMULLIT,
     34HEHCF,6HFG HNY,4HCOMB,6HHRSI/L,4HRSI ,6HSIP+RT,4HU560/
      COMMON/DIBUJO/BDYPNT(4),TRANME(6),ICASE
C
C     SUBROUTINE TO WRITE OUT INPUT PARAMETERS
C
      IMAX=NODES
      WRITE(6,1) TRANME,BDYPNT,ICASE
    1 FORMAT(1H1,' TRAJECTORY ',1X,6A6,5X,'BODY POINT',1X,4A6,5X,
     1 'ICASE',I5/' MINIATURE VERSION OF JA70 (MINIVER)')
      IF(ICASE .NE. 1) GO TO 419
      BDYPNT(1)=6H
      BDYPNT(2)=6H
      BDYPNT(3)=6H
      BDYPNT(4)=6H
  419 CONTINUE
      WRITE(6,2)T1,DT1,T2,DT2,T3,DT3,T4,DTCALC,DTEMAX
    2 FORMAT(//7H TIMING/
```

```
     15X,11HT1          =F9.3/
     25X,11HDT1         =F9.3/
     35X,11HT2          =F9.3/
     45X,11HDT2         =F9.3/
     55X,11HT3          =F9.3/
     65X,11HDT3         =F9.3/
     75X,11HT4          =F9.3/
     85X,11HDT CALC     =F9.3/
     95X,11HDTEMP MAX =F9.3/)
      WRITE(6,3) HTFLAG,RN,EL,ENL,ENT,PHI,VRLFLG
    3 FORMAT(14H HEAT TRANSFER/
     15X,11HHT METHOD =F9.3/
     25X,11HRN          =F9.3/
     35X,11HL           =F9.3/
     45X,11HN SUB L     =F9.3/
     55X,11HN SUB T     =F9.3/
     65X,11HPHI         =F9.3/
     75X,11HVIRT.L OPT=F9.3 )
      NHFLAG=HTFLAG+.001
      IF(NHFLAG.EQ.4.AND.RANFLG.GT.0.) WRITE(6,301)
  301 FORMAT(5X,55HVON KARMAN REYNOLDS ANALOGY USED FOR TURBULENT HEATIN
     1G. )
      NT3=ENT3+.0001
      IF(NT3 .LE. 0) GO TO 2011
      WRITE(6,5001)
 5001 FORMAT(/5X,35HTIME DEPENDENT GEOMETRIC PARAMETERS /,
     15X,4HTIME,6X,2HRN,8X,1HL,9X,3HPHI,5X,8HSCRIPT F/)
      DO 2010 LO=1,NT3
      WRITE(6,50) TMZ(LO),RNZ(LO),ELZ(LO),PHIZ(LO),EMIZ(LO)
2010  CONTINUE
2011  CONTINUE
   50 FORMAT(2(F10.2,F10.4,F10.2,F10.2,F10.4))
      IF(CFFLG .GT. 0)WRITE(6,4) CFFLG,DSUBO,ELMBDA,UDOT,CORNR
    4 FORMAT(/10H CROSSFLOW/
     15X,11HOPTION FLG=F9.3/
     25X,11HD SUB O     =F9.3/
     35X,11HLAMBDA      =F9.3/
     45X,11HU DOT       =F9.3/,
     55X,11HCORNER R    =F9.3/)
      WRITE(6,5) AKL,AKT,HFAC
    5 FORMAT(/23H MULTIPLICATION FACTORS/
     15X,11HK SUB L 1 =F9.3/
     25X,11HK SUB T 1 =F9.3/5X,11HH FAC      =F9.3/)
      NT2=ENT2+.001
      IF(NT2 .LE. 0) GO TO 2030
      WRITE(6,666)
  666 FORMAT(12X,22HTIME DEPENDANT FACTORS/
     15X,4HTIME,8X,9HK SUB L 2,4X, 9HK SUB T 2/)
      DO 3020 LO=1,NT2
      WRITE(6,6) TK1(LO),AKL2(LO),AKT2(LO)
3020  CONTINUE
2030  CONTINUE
   6  FORMAT(2(4X,F9.3,3X,F9.4,4X,F9.4))
      NM3 = ENM3 + .001
      IF(NM3 .LE. 0) GO TO 2050
      DO 3040 LO=1,NM3
      WRITE(6,7) TMACH(LO),AKL3(LO),AKT3(LO)
3040  CONTINUE
```

```
116:3060  CONTINUE
117:     7 FORMAT(/5X,35HUPSTREAM MACH NO. DEPENDANT FACTORS/
118:      15X,8HMACH NO.,4X,9HK SUB L 3,4X,9HK SUB T 3/
119:      2(4X,F9.3,3X,F9.4,4X,F9.4))
120:       NTFAC=NTFAC+.001
121:       IF(NTFAC .LE. 0) GO TO 2070
122:       DO 3060 LO=1,NTFAC
123:       WRITE(6,35) TK2(LO),HFACT
124:3060   CONTINUE
125:2070   CONTINUE
126:    35 FORMAT(/5X,26HTIME DEPENDENT H/H FACTORS/9X,4HTIME,8X,
127:      *10HH/H FACTOR/(6X,F9.3,5X,F9.4))
128:       NN = NODES + .0001
129:       IF(NN.GT.0) GO TO 150
130:  100 MATL=EMATL+.001
131:       LL=2*MATL+1
132:       WRITE(6,8) EMATL,TAGMAT(LL),TAGMAT(LL+1),DEL,EMIS,TIN,RHOM,CPM
133:     8 FORMAT(/9H MATERIAL/
134:      15X,11HMATL NO.   =F9.3,3X,A6,A4/
135:      25X,11HTHICKNESS =F9.3/
136:      35X,11HEMISSIVITY=F9.3/
137:      45X,11HINIT TEMP =F9.3/
138:      55X,11HDENSITY   =F9.3/
139:      65X,11HSP. HEAT  =F9.3/)
140:       NMTL=EMATL+.001
141:       IF(NMTL .LE. 0) GO TO 150
142:       WRITE(6,9)
143:     9 FORMAT(/5X,23HTEMP. DEPENDANT C SUB P/
144:      15X,5HTEMP.,5X,13HSPECIFIC HEAT/)
145:       WRITE(6,909) (TMAT(LO),CPMAT(LO),LO=1,NMTL)
146:  909  FORMAT(4X,F7.1,6X,F7.4)
147:  150  CONTINUE
148:       IF (IOPT .EQ. 0.) GO TO 300
149:       WRITE(6,3000) IOPT, TOPT, PERCNT
150: 3000 FORMAT(1H0, 12HOPTIMIZATION/ 1H , 4X, 11HOPTION    =, I3/
151:     1         1H , 4X, 11HOPT. TEMP.=, F9.3/ 1H , 4X, 11HCONV.CRIT.=,
152:     2         F9.3)
153:  300 WRITE (6,10)
154:   10 FORMAT(/10H FLOWFIELD/
155:      110X,4HFLAG,6X,5HANGLE)
156:       DO 12 K=1,6
157:       IF( GF(K) .GT.0.) WRITE(6,11) K, GF(K) , ALFA(K)
158:   11 FORMAT(I5,5X,F4.0,5X,F6.2)
159:   12 CONTINUE
160:       DO 13 K=1,3
161:       IF( HH(K) .GT. 0) WRITE(6,11) K,HH(K),ALFA(K+7)
162:   13  CONTINUE
163:       NT1=ENT1+.001
164:       IF(NT1 .LE. 0) GO TO 2110
165:       WRITE(6,14)
166:       DO 2100 LO=1,NT1
167:       WRITE(6,1414) TA(LO),A1(LO),A2(LO),A3(LO),A4(LO),A5(LO),
168:      1 A6(LO),A7(LO),A8(LO),A9(LO)
169:2100   CONTINUE
170:2110   CONTINUE
171:   14 FORMAT(40X,31HTIME DEPENDANT FLOWFIELD ANGLES/
172:      17X,4HTIME,7X,7HANGLE 1,3X,7HANGLE 2,3X,7HANGLE 3,3X,7HANGLE 4,3X,
173:      27HANGLE 5,3X,7HANGLE 6,3X,7HANGLE 7,3X,7HANGLE 8,3X,7HANGLE 9/)
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```
 1414  FORMAT(3X,F10.4,2X,9F10.3)
  141 WRITE(6,15)
   15 FORMAT(/11H TRANSITION/5X,6HOPTION)
      NTR=TRFLAG+.001
      IF(NTRFLAG.LT.2.) GO TO 30
      IF(NTR.EQ.0) GO TO 23
      IF (NTR .GT. 8) GO TO 28
      IF (NTR .EQ. 8) GO TO 29
      IF(NTR-2)21,22,16
   16 IF(NTR-6)23,26,27
   21 WRITE(6,210) PARA1,PARA1,PARA2,PARA2
  210 FORMAT(/7X,1H1,7X,17HLAMINAR PRIOR TO ,F8.2, 5H SEC./
     115X,17HTRANSITIONAL FROM,F8.2, 8H SEC. TO,F8.2,5H SEC./
     215X,15HTURBULENT AFTER,F10.2,5H SEC./)
      GO TO 30
   22 WRITE(6,220) PARA1,PARA1,PARA2,PARA2
  220 FORMAT(7X,1H2,7X,19HTURBULENT PRIOR TO ,F8.2,5H SEC./
     115X,17HTRANSITIONAL FROM,F8.2, 8H SEC. TO,F8.2,5H SEC./
     215X,13HLAMINAR AFTER,5X,F8.2, 5H SEC./)
      GO TO 30
   23 P1=PARA1
      P2=PARA2
      IF(P2.EQ.0.) P2=P1
      IF(P2.LT.P1) GO TO 230
      GO TO 231
  230 P2R=P2
      P2=P1
      P1=P2R
  231 IF(NTR.EQ.4) GO TO 24
      IF(NTR.EQ.5) GO TO 25
      WRITE(6,232) P1,P1,P2,P2
  232 FORMAT(7X,1H3,7X,26HLAMINAR BELOW RE L        =F10.0/
     115X,26HTRANSITIONAL BETWEEN RE L=F10.0,13H  AND  RE L =F10.0/
     215X,26HTURBULENT ABOVE RE L      =F10.0/)
      GO TO 30
   24 WRITE(6,240) P1,P1,P2,P2
  240 FORMAT(7X,1H4,7X,30HLAMINAR BELOW RE THETA       =F8.2/
     115X,30HTRANSITIONAL BETWEEN RE THETA=F8.2,15H AND RE THETA =F8.2/
     215X,30HTURBULENT ABOVE RE THETA     =F8.2/)
      GO TO 30
   25 WRITE(6,250) P1,P1,P2,P2
  250 FORMAT(7X,1H5,7X,30HLAMINAR BELOW A PARAMETER OF    ,F7.3/
     115X,30HTRANSITIONAL BETWEEN PARAM OF F7.3,4H AND,F7.3/
     215X,30HTURBULENT ABOVE A PARAMETER OF,F7.3/)
      GO TO 30
   26 WRITE(6,260) ELFAC
  260 FORMAT(7X,1H6,7X,46HLAMINAR FOR L LESS THAN TRANS LENGTH (BASED ON
     1,32H BUILT-IN TRANSITION PARAM CURVE  /
     215X,46HTURBULENT WHEN L IS GREATER THAN L TRANS TIMES ,F7.2/
     315X,33HTRANSITIONAL BETWEEN THOSE LIMITS/)
      GO TO 30
   27 WRITE(6,270) ELFAC
  270 FORMAT(7X,1H7,7X,46HLAMINAR FOR L LESS THAN TRANS LENGTH (BASED ON
     1,32H BUILT-IN TRANSITION RE RE CURVE  /
     215X,46HTURBULENT WHEN L IS GREATER THAN L TRANS TIMES ,F7.2/
     315X,33HTRANSITIONAL BETWEEN THOSE LIMITS/)
      GO TO 30
   29 WRITE (6,290)
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  290 FORMAT(15X,26HR. I. TRANSITION CRITERION)
      IF (ARIT .LT. .001) GO TO 292
      WRITE(6,291)
  291 FORMAT(7X,1H8,7X,37HLAMINAR BELOW AN  RE THETA/ML (ALPHA))
      GO TO 294
  292 WRITE (6,293) PARA1
  293 FORMAT(7X,1H8,7X,31HLAMINAR BELOW     RE THETA/ML =F7.1)
  294 WRITE(6,295)
  295 FORMAT(15X,78HTURBULENT ABOVE   RE L        =    2.0 X RE L  BASED
     1 ON AN RE THETA/ML (ALPHA)/15X,33HTRANSITIONAL BETWEEN THESE LIMIT
     1S/)
   30 NTF=ATFLAG+.001
      NT=ENTR+.001
      IF(NTF.EQ.1) GO TO 33
      IF (ARIDEF .GT. .001) GO TO 305
      IF (NFF .GT. .001) GO TO 307
      WRITE(6,3111)
      DO 2020 LO=1,NT
      WRITE(6,31) TZ(LO),ZZ(LO),VZ(LO)
2020  CONTINUE
 3111 FORMAT(11H TRAJECTORY/
     1 15X,4HTIME,8X,8HALTITUDE,7X,8HVELOCITY/)
   31 FORMAT(F10.2,7X,F8.0,7X,F7.1)
      GO TO 309
 305  CONTINUE
      DO 3030 LO=1,NT
      WRITE(6,306) TZ(LO),ZZ(LO),VZ(LO),ALFA0T(LO),DELTAT(LO)
3030  CONTINUE
  306 FORMAT(11H TRAJECTORY/
     1 5X,4HTIME,8X,8HALTITUDE,7X,8HVELOCITY,7X,5HALPHA,9X,5HDELTA/
     1(F10.2,7X,F8.0,7X,F7.1,7X,F7.3,7X,F7.3))
      GO TO 309
 307  CONTINUE
      WRITE(6,3088)
      DO 2040 LO=1,NT
      WRITE(6,308) TZ(LO),ZZ(LO),VZ(LO),ALFA0T(LO)
2040  CONTINUE
 3088 FORMAT(11H TRAJECTORY/
     1 5X,4HTIME,8X,8HALTITUDE,7X,8HVELOCITY,7X,5HALPHA)
308   FORMAT(F10.2,7X,F8.0,7X,F7.1,7X,F7.3)
  309 CONTINUE
      IF(NTF.EQ.0) WRITE (6,310)
  310 FORMAT(/21H 1962 ICAO ATMOSPHERE/)
      IF(NTF.EQ.4) WRITE(6,311)
  311 FORMAT(/25H 1963 PAFB STD ATMOSPHERE)
      IF(NTF.NE.2) GO TO 99
      NAL=ARIDEF+.001
      DO 3050 LO=1,NAL
      WRITE(6,32) ALFA0T(LO),DELTAT(LO),FSPRES(LO)
3050  CONTINUE
   32 FORMAT(/11H ATMOSPHERE/
     1 15X, 8HALTITUDE,7X,9HF.S.TEMP.,6X,10HF.S.PRESS./
     1 2(4X,F8.0,8X,F8.2,7X,E11.5))
      GO TO 99
  33  CONTINUE
      DO 2060 LO=1,NT
      WRITE(6,34) TZ(LO),VZ(LO),DELTAT(LO),FSPRES(LO)
2060  CONTINUE
```

```
      34 FORMAT(23H FREE STREAM PROPERTIES/
     1  15X,4HTIME,6X,8HVELOCITY,7X, 9HF.S.TEMP.,5X,10HF.S.PRESS./
     2  2(2X,F8.2,5X,F7.0,9X,F8.2,5X,E12.6))
          GO TO 99
      28 WRITE(6,290) NTR
     290 FORMAT(18H TRANSITION OPTION,I5,49H IS CONSIDERED TO BE ERRONEOUS,
     1AND IN POOR TASTE.,39HIT WILL BE SET EQUAL TO 3, RE L TO 1.E6/)
          TRFLAG=3.
          PARA1=1000000.
          PARA2=PARA1
          GO TO 141
      99 CONTINUE
          RETURN
          END
```

9. MINIVER PLOT PACKAGE ROUTINES

```
      SUBROUTINE PLOTLO(TIME,NHFLAG,ARIDEF,ATRE,TZ,ZZ,VZ,ALFA0T,
     1 DELTAT,ITHICK,LNGPLT,ITINIT,MAXTME,DEVICE,IHCOPY)
C
C     DECLARATIVE STATEMENTS
C
      INTEGER BDYPNT,TRANME,DEVICE
      PARAMETER J1=17, J2=500, J3=32
      DIMENSION TIME1(J2),XME1(J2),REL1(J2),QC1(J2),QC1T(J2),
     *TREF1(J2),TW1(J2),PE1(J2),CP1(J2),BETA1(J2),ALPHA1(J2),AKLZ1(J2),
     * HFACZ1(J2),QT(2),TT(2),TW2(J2)
      DIMENSION VZ(50),TZ(50),ALFA0T(50),ZZ(50),DELTAT(50)
      DIMENSION BDYPNT(4),TRANME(6),IBUF(200),LABEL(20,6),IPAK(40)
C
C
C
      COMMON/LABS/LABEL
      COMMON/DIBUJO/BDYPNT,TRANME,ICASE
      COMMON/AXDAT/XOR,XSTEP,XAXIS
      COMMON/ARRAY/QC1,TIME1,BETA1,ALPHA1,AKLZ1,
     *HFACZ1,XME1,REL1,PE1,CP1,TW1,TREF1,QT,TT,TW2,QC1T
      COMMON/MAX/QM,BETAM,AKLZM,HFACZM,PEM,CPPM,TREFM
      COMMON/PLOTT/JRCD,IT,NT,NT2,NFF,PCT
      COMMON IPT,IBUF,IPAK
C
C
C     SET X-AXIS LABEL LIMITS AND INCREAMENTS
C
      OMAX=MAXTME
      DELTX=MAXTME/10
C
C       INITIALIZE PLOTTING DEVICE
C
      DEVICE=1
      GO TO(310,320,330),DEVICE
C
C       INITIALIZE TEKTRONIX CRT
C
  310 CONTINUE
      CALL ERASE
C
C       START PLOTTING
C
      CALL TEKEGM(480)
      CALL BASALF('L/CSTD  ')
      CALL MIXALF ('STANDARD')
      GO TO 340
C
C     INITIALIZE MOPS TERMINAL
C
  320 CONTINUE
C
C       INSERT CODING HERE
C
      GO TO 340
C
C     INITIALIZE MICROFILM HERE
C
C
  330 CONTINUE
C
C
C
  340 CONTINUE
C       PLOT REFERENCE PLOTS
C
      IF(ICASE-2) 5, 10, 20
C
C     REFERENCE SPHERE PLOTS
C
    5 CONTINUE
C
C     TIME VS ALTITUDE
C
      CALL AXSPLT(0.0,OMAX,8.0,XOR,XSTEP,XAXIS)
```

```
C
      CALL HNDYLO(IHCOPY,TZ,ZZ,NT,1,1)
C
C         TIME VS VELOCITY
C
      CALL HNDYLO(IHCOPY,TZ,UZ,NT,2,1)
C
C       TIME VS ANGLE OF ATTACK
C
       IF(ALFA0T .LE. 0) GO TO  10
C
      CALL HNDYLO(IHCOPY,TZ,ALFA0T,NT,3,1)
C
      GO TO 40
C
C       TIME VS QDOT REF
C
   10 CONTINUE
      CALL DSMMLO(IT,QC1T,YMIN,YMAX)
      CALL AXSPLT(0.0,YMAX,6.0,YOR,YSTEP,YAXIS)
      CALL PPLOT1(11,ICASE)
C     CALL DLMK1(0.0,2.5,5.0,6.2,3)
      CALL DRAWLO(XOR,XSTEP,XAXIS,YOR,YSTEP,YAXIS,TIME1,QC1,IT,3,3
     1 IHCOPY)
      CALL DRAWLO(XOR,XSTEP,XAXIS,YOR,YSTEP,YAXIS,TIME1,QC1T,IT,2,
     1 IHCOPY)
      CALL LINES('(T)W (R)AD (E)Q (T)EMP.$',IPAK,1)
      CALL LINES('(T)W       (D)EG. (F)$',IPAK,2)
      IPT=-1
      CALL LEGEND(IPAK,2,2.5,6.2)
      CALL INTNO(ITINIT,3.4,6.2)
      IF(IHCOPY .LE. 0) GO TO 99
      CALL HDCOPY
      CALL ERASE
   99 CONTINUE
      CALL ENDPL(0)
      GO TO 40
C
C
C
C
   20 CONTINUE
C     IF(LNGPLT .EQ. 0) GO TO 30
C
C
C       LONG PLOT
C
C       LAMINAR FACTORS
C
C
C       LAMINAR FACTORS
C
      CALL HNDYLO(IHCOPY,TIME1,AKLZ1,IT,4,3)
C
      IF(ARIDEF .NE. 1) GO TO 26
C
C       DEFLECTION FACTORS
C
      CALL HNDYLO(IHCOPY,TIME1,HFACZ1,IT,5,3)
C
C
   26 CONTINUE
C
C       LOCAL MACH NUMBER
C
      CALL HNDYLO(IHCOPY,TIME1,XME1,IT,6,3)
C
C
      IF(NHFLAG .EQ. 1) GO TO 27
C
C       REYNOLDS NUMBER LOCAL/1.0E6
C
      CALL HNDYLO(IHCOPY,TIME1,REL1,IT,7,3)
C
```

```
148:C
149:       GO TO 28
150:C
151:    27  CONTINUE
152:C
153:C
154:C            REFAC
155:C
156:       CALL HNDYLO(IHCOPY,TIME1,HFACZ1,IT,8,3)
157:C
158:    28   CONTINUE
159:C
160:C       LOCAL  PRESSURE   LBF/FT-SQ
161:C
162:       CALL HNDYLO(IHCOPY,TIME1,PE1,IT,9,3)
163:C
164:C
165:C        C SUB P
166:C
167:       CALL HNDYLO(IHCOPY,TIME1,CP1,IT,10,3)
168:C
169:C       SHORT PLOTS
170:C
171:    30   CONTINUE
172:C
173:C
174:       IF(ARIDEF .NE. 1 ) GO TO 210
175:C
176:C       CONTROL SURFACE DEFLECTION PLOT
177:C
178:C      CALL HNDYLO(IHCOPY,TIME1,DELTAT,IT,13,3)
179:C
180:  210  CONTINUE
181:C
182:C       Q  DOT (BTU/FT-SQ-SEC) PLOT
183:C
184:       CALL HNDYLO(IHCOPY,TIME1,QC1,IT,11,3)
185:C
186:C        TITLE TWAL (DEG F) PLOT
187:C
188:       CALL HNDYLO(IHCOPY,TIME1,TREF1,IT,12,3)
189:C
190:       IF(ATRE .GT. 0.001) GO TO 236
191:C
192:C       T WALL (DEG F) PLOT
193:C
194:       CALL HNDYLO(IHCOPY,TIME1,TW1,IT,12,3)
195:C
196:    236  CONTINUE
197:C
198:       IF(ITHICK .NE. 0) GO TO 37
199:        GO TO 40
200:C
201:  37   CONTINUE
202:C
203:C       TWALL (DEG F) PLOT TW2
204:C
205:       CALL HNDYLO(IHCOPY,TIME1,TW2,IT,12,3)
206:C
207:    40  CONTINUE
208:       RETURN
209:       END
```

```
      SUBROUTINE HNDYLO(IHCOPY,XARRAY,YARRAY,NP,ILABL,IPASS)
C
C     DECLARATIVE STATEMENTS
C
      INTEGER BDYPNT,TRANME
      DIMENSION BDYPNT(4),TRANME(6),LABEL(20,6),IPAK(40)
      DIMENSION XARRAY(1),YARRAY(1)
      DIMENSION IBUF(200)
C
C
      COMMON/LABS/LABEL
      COMMON/DIBUJO/BDYPNT,TRANME,ICASE
      COMMON/AXDAT/XOR,XSTEP,XAXIS
      COMMON IPT,IBUF,IPAK
C
      CALL PPLOT1(ILABL,ICASE)
      CALL DSMMLO(NP,YARRAY,YMIN,YMAX)
      CALL AXSPLT(0.0,YMAX,6.0,YOR,YSTEP,YAXIS)
      CALL DRAWLO(XOR,XSTEP,XAXIS,YOR,YSTEP,YAXIS,XARRAY,YARRAY,NP,
     1 1,IPASS,IHCOPY)
C
      RETURN
      END
```

```
C
C       SUBROUTINE DRAWLO, WRITTEN BY LORENZO OLMEDO OF LEC JULY,1979
C
C       THIS ROUTINE COLLECTS DISSPLA ROUTINES FOR THE PURPOSE OF
C       GENERATING A PLOT, AND LABELING OF THE X-AXIS.
C       THE Y-AXIS ARE LABELED IN A ROUTINE CALLED PPLOT1
C
C       ARGUMENTS
C
C       XO      - X-ORIGIN
C       XD      - X-INCREAMENTS
C       XL      - X-AXIS RANGE
C       YO      - Y-ORIGIN
C       YD      - Y-INCREAMENTS
C       YL      - Y-AXIS RANGE
C       XARRAY  - ARRAY TO BE PLOTTED ON THE X-AXIS
C       YARRAY  - ARRAY TO BE PLOTTED ON THE Y-AXIS
C       NPOINT  - NUMBER OF POINTS TO BE PLOTTED
C       IFLAG   - FLAG TO INDICATE CLOSING OF A GIVEN FRAME
C                 IFLAG=1 ONE PLOT PER FRAME
C                 IFLAG=2 TWO PLOTS PER FRAME
C                 IFLAG=3 FIRST PLOT OF A SET OF TWO
C
      SUBROUTINE DRAWLO(XO,XD,XL,YO,YD,YL,XARRAY,YARRAY,NPOINT,IFLAG,
     1 IPASS,IHCOPY)
C
C      DECLARATIVE STATEMENTS
C
       INTEGER BDYPNT,TRANME
C
       DIMENSION XARRAY(1),YARRAY(1)
       DIMENSION IBUF(200),BDYPNT(4),TRANME(6),IPAK(40)
C
       COMMON IPT,IBUF,IPAK
       COMMON/DIBUJO/BDYPNT,TRANME,ICASE
C
C      ROUTINES CALLED IN THIS PGM. ARE PART OF DISSPLA SYSTEM
C
       GO TO(1,20,2), IFLAG
    1  CALL XINTAX
       CALL YINTAX
       CALL YAXANG(0.0)
       GO TO 16
    2  CALL XINTAX
       CALL YAXANG(0.0)
   16  CONTINUE
       CALL GRAPH(XO,XD,YO,YD)
       CALL GRID(2,2)
C      CALL CDATE(DATE)
       CALL ERTRAN(9,DATE,TIME)
       CALL HEIGHT(0.10)
       CALL MESSAG(DATE,6,8.0,-0.7)
       CALL HEIGHT(0.18)
       CALL MESSAG('(T)RAJECTORY S',100,0.1,7.0)
       CALL MESSAG(TRANME,36,1.0,7.0)
       CALL MESSAG(BDYPNT,24,5.0,7.0)
       CALL HEIGHT(.14)
```

```
      80   80  CONTINUE
      79:       CALL NOCHEK
      80:       CALL GRACE(0.0)
      81:       CALL CURVE(XARRAY,YARRAY,NPOINT,1)
      82:       IF(IFLAG .EQ. 3 .OR. IFLAG .EQ. 2) GO TO 150
      83:       IF(IMCOPY .LE. 0) GO TO 99
      84:       CALL ENDPL(0)
      85:       CALL HDCOPY
      86:       CALL ERASE
      87:       GO TO 100
      88:   99  CONTINUE
      89:       CALL ENDPL(0)
      70:       READ(5,107)
      71:  107 FORMAT( )
      72:       CALL ERASE
      73:  100  CONTINUE
      74:  150  CONTINUE
      75:       RETURN
      76:       END
```

```
      SUBROUTINE DSMMLO(NP,A,YORI,YLAST)
      DIMENSION A (500)
      YORI=A(1)
      YLAST=A(1)
      DO 10 I=1,NP
      YORI=AMIN1(YORI,A(I))
      YLAST=AMAX1(YLAST,A(I))
10    CONTINUE
      RETURN
      END
```

```
C       SUBROUTINE PPLOT1(ILABL,ICASE)
C
C      WRITTEN BY LORENZO OLMEDO
C
C      THE PURPOSE OF THIS SUBROUTINE IS TO PLACE A LABEL
C      ON THE Y AXIS
C
C      ARGUMENT: ILABL, WHICH IS AN INTEGER INDICATING
C      WHICH LABEL IS TO BE WRITTEN ON Y-AXIS
C      THE LABEL IS DEFINED IN A TWO DIMENSION ARRAY
C      CALLLED LABEL.
C
C      THERE CAN BE AS MANY AS 20 LABELS , WHICH MUST BE
C      DEFINED IN SUBROUTINE PPLOT. EACH LABEL CONTAIN 6 WORDS.
C
       SUBROUTINE PPLOT1(ILABL,ICASE)
       DIMENSION LABEL(20,6),IBUF(200),LABF(6),IPAK(40)
       COMMON/LABS/LABEL
       COMMON IPT,IBUF,IPAK
C
C
C
       DO 10 J=1,6
       LABF(J)=LABEL(ILABL,J)
  10   CONTINUE
       CALL TITLE(1H ,-1,'(T)IME (()SECONDS)$',100,LABF,100,8.0,6.0)
       RETURN
       END
```

10. OFF-LINE PLOTTING

Off-line plotting is basically the same as explained in section 4, except that the data is ready to be plotted and stored in a secured file. The name of the file containing the runstream is different; it is OFFLPT (off-line plotting) and resides in secured file ES35-N06516*LOREN.

The runstream listing for OFFLPT is shown in figure 2; the program listing is shown in figure 3.

```
 1:@FREE TPF$.
 2:@ASG,A ES32-L78771*OLMEDO
 3:@USE OL.,ES32-L78771*OLMEDO
 4:@ASG,T 9.,F/1/TRK/500
 5:@ASG,T TPF$.,F/1/TRK/800
 6:@ERS TPF$.
 7:@COPY ES35-N06216*LOREN.,TPF$
 8:@ED,I TPF$.MAP
 9:LIB TPF$
10:LIB DISSPLA*TRY
11:SEG MAIN
12:NOT DISSPLA*TRY.QQTKEG
13:IN LOREN.QQTKEG
14:IN DEMOMA,PLOTDE,MENUPT
15:END
16:@PREP
17:@MAP TPF$.MAP,TPF$.ABS
18:@XQT ABS
19:@ADD OL.RTLS-EX/32779
20:@ADD OL.C1234/DATA
21:@ADD OL.C12345/DATA
22:@ADD OL.BD3RD1/DATA
23:@ADD OL.DIRECTORY
```

Figure 2. - Runstream listing OFFLPT.

```
C
C      DECLARATIVE STATEMENTS
C
       INTEGER BDYPNT,TRANME,DEVICE
       PARAMETER J1=17, J2=500, J3=32
       DIMENSION TIME1(J2),XME1(J2),REL1(J2),QC1(J2),QC1T(J2),
     $TREF1(J2),TU1(J2),PE1(J2),CP1(J2),BETA1(J2),ALPHA1(J2),AKLZ1(J2),
     $ MFACZ1(J2),QT(2),TT(2)
       DIMENSION VZ(50),TZ(50),ALFA0T(50),ZZ(50),DELTAT(50)
       DIMENSION BDYPNT(4),TRANME(6),IBUF(200),LABEL(20,6),IPAK(40)
       DIMENSION ICARD(14)
C
C
C
       COMMON/OPTION/IOPT,IOPT1,NT,IT,MENUFG
       COMMON/LABS/LABEL
       COMMON/DIBUJO/BDYPNT,TRANME,ICASE
       COMMON/AXDAT/XOR,XSTEP,XAXIS
       COMMON/ARRAY/QC1,TIME1,BETA1,ALPHA1,AKLZ1,
     $MFACZ1,XME1,REL1,PE1,CP1,TU1,TREF1,QT,TT,TU2(J2),QC1T
       COMMON IPT,IBUF,IPAK
C
C      DEFINE PLOT LABELS
C
       DATA (LABEL( 1,J),J=1,6)/36H (A)LTITUDE (()FEET)$                /
       DATA (LABEL( 2,J),J=1,6)/36H (V)ELOCITY (()FT/SEC)$              /
       DATA (LABEL( 3,J),J=1,6)/36H (A)LPHA (()DEGREES)$                /
       DATA (LABEL( 4,J),J=1,6)/36H (L)AMINAR (F)ACTORS$                /
       DATA (LABEL( 5,J),J=1,6)/36H (D)EFLECTION (F)ACTORS$             /
       DATA (LABEL( 6,J),J=1,6)/36H (L)OCAL (M)ACH (N)UMBER$            /
       DATA (LABEL( 7,J),J=1,6)/36H (L)OCAL (R)EYNOLDS (N)OS./1.0(E)6$  /
       DATA (LABEL( 8,J),J=1,6)/36H (R)EFAC$                            /
       DATA (LABEL( 9,J),J=1,6)/36H (L)OCAL (P)RESSURE (()LBF/FT-SQ)$   /
       DATA (LABEL(10,J),J=1,6)/36H (C) P$                              /
       DATA (LABEL(11,J),J=1,6)/36H (Q) (D)OT ((B)TU/FT-SQ-SEC)$        /
       DATA (LABEL(12,J),J=1,6)/36H (T) (W)ALL (()DEG (F))$             /
       DATA (LABEL(13,J),J=1,6)/36H (C)ONTROL (S)URFACE DEF.(()DEG.)$   /
       DATA (LABEL(14,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)$   /
       DATA (LABEL(15,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)$   /
       DATA (LABEL(16,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)$   /
       DATA (LABEL(17,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)$   /
       DATA (LABEL(18,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)$   /
       DATA (LABEL(19,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)$   /
       DATA (LABEL(20,J),J=1,6)/36H  (THIS LABEL IS NOT USED AS YET)$   /
C
C        START OF PROGRAM
C
       MENUFG=0
       DO 6 I=1,10000
                    READ(5,9,END=26) ICARD
                    WRITE(9,9) ICARD
  6    CONTINUE
C
   26  CONTINUE
       END FILE 9
   9   FORMAT(13A6,A2  )
 100   CONTINUE
```

```
      IHCOPY=0
      DEVICE=1
C
C
    8 CONTINUE
C
C     ERASE SCREEN AND CALL MENU
C
      CALL ERASE
      CALL MENUPT
C
      WRITE(6,1)
    1 FORMAT(' HARD COPY OF PLOTS YES OR NO?'/
     1 ' ENTER PROPER RESPONSE Y OR N')
      READ(5,2) KOPY
    2 FORMAT(A1)
      IF(KOPY .EQ. 1HY) IHCOPY=1
      REWIND 9
C
C     READ DATA NEEDED FOR PLOT PROGRAM
C
      DO 60 J=1,IOPT
      READ(9,200,END=150) ITINIT,ICASE,LNGPLT,NHFLAG,ITHICK,ARIDEF,ATRE
      READ(9,220)(BDYPNT(I),I=1,4),(TRANME(I),I=1,6),ICASE,NT,IT
      IF( J .GT. 1 ) GO TO 25
      READ(9,230) (TZ(I),ZZ(I),UZ(I),ALFA0T(I),I=1,NT)
      MAXTME=TZ(NT)
      GO TO 60
   25 IF( J .GT. 2 ) GO TO 35
      READ(9,240) (TIME1(I),QC1(I),QC1T(I),I=1,IT)
      GO TO 60
   35 CONTINUE
      IF(J .GT. 5) GO TO 45
      READ(9,240)(TIME1(I),AKLZ1(I),HFACZ1(I),XME1(I),REL1(I),
     1 PE1(I),CP1(I),QC1(I),TREF1(I),TU1(I),TU2(I),
     2 I=1,IT)
      READ(9,240) (DELTAT(I),I=1,NT)
      GO TO 60
   45 CONTINUE
      READ(9,230) (TZ(I),ZZ(I),UZ(I),ALFA0T(I),I=1,NT)
      MAXTME=TZ(NT)
C
      READ(9,240)(TIME1(I),AKLZ1(I),HFACZ1(I),XME1(I),REL1(I),
     1 PE1(I),CP1(I),QC1(I),TREF1(I),TU1(I),TU2(I),
     2 I=1,IT)
      READ(9,240) (DELTAT(I),I=1,NT)
   60 CONTINUE
C
C     CALL THE PLOT ROUTINE
C
C
      CALL PLOTDE(TIME,NHFLAG,ARIDEF,ATRE,TZ,ZZ,UZ,ALFA0T,
     1 DELTAT,ITHICK,LNGPLT,ITINIT,MAXTME,DEVICE,IHCOPY)
C
C     ASK USER IF HE WANTS MORE PLOTS
C
      WRITE(6,11)
   11 FORMAT(' ANY MORE PLOTS?'/
     1 ' ENTER PROPER RESPONSE (Y/N)')
```

```
C
C       GET USER'S RESPONSE
C
        READ(5,2) IANS
        IF(IANS .EQ. 1HY) GO TO 100
        GO TO 150
200     FORMAT(5I5,2F10.0)
210     FORMAT(6A6)
220     FORMAT(4A6,1X,6A6,1X,3I5)
230     FORMAT(8F10.0)
240     FORMAT(6E12.5)
150     CONTINUE
        STOP
        END
```

```
      SUBROUTINE PLOTDE(TIME,NWFLAG,ARIDEF,ATRE,TZ,ZZ,VZ,ALFA0T,
     1 DELTAT,ITNICK,LNGPLT,ITINIT,MAXTME,DEVICE,IHCOPY)

C
C     DECLARATIVE STATEMENTS
C
      INTEGER BDYPNT,TRANME,DEVICE
      PARAMETER J1=17, J2=500, J3=32
      DIMENSION TIME1(J2),XME1(J2),REL1(J2),QC1(J2),QC1T(J2),
     *TREF1(J2),TW1(J2),PE1(J2),CP1(J2),BETA1(J2),ALPHA1(J2),AKLZ1(J2),
     * HFACZ1(J2),QT(2),TT(2),TW2(J2)
      DIMENSION VZ(50),TZ(50),ALFA0T(50),ZZ(50),DELTAT(50)
      DIMENSION BDYPNT(4),TRANME(6),IBUF(200),LABEL(20,6),IPAK(40)


      COMMON/OPTION/IOPT,IOPT1,NT,IT,MENUFG
      COMMON/LABS/LABEL
      COMMON/DIBUJO/BDYPNT,TRANME,ICASE
      COMMON/AXDAT/XOR,XSTEP,XAXIS
      COMMON/ARRAY/QC1,TIME1,BETA1,ALPHA1,AKLZ1,
     *HFACZ1,XME1,REL1,PE1,CP1,TW1,TREF1,QT,TT,TW2,QC1T
      COMMON/MAX/QM,BETAM,AKLZM,HFACZM,PEM,CPPM,TREFM
      COMMON IPT,IBUF,IPAK

C
C      SET X-AXIS LABEL LIMITS AND INCREAMENTS
C
      OMAX=MAXTME
      DELTX=MAXTME/10
C
C        INITIALIZE PLOTTING DEVICE
C
      DEVICE=1
      GO TO(310,320,330),,DEVICE
C
C        INITIALIZE TEKTRONIX CRT
C
  310 CONTINUE
      CALL ERASE
C
C         START PLOTTING
C
      CALL TEKEGM(480)
      CALL BASALF('L/CSTD')
      CALL MIXALF ('STANDARD')
      CALL AXSPLT(0.0,OMAX,8.0,XOR,XSTEP,XAXIS)
      GO TO 340
C
C         INITIALIZE MOPS TERMINAL
C
  320 CONTINUE
C
C           INSERT CODING HERE
C
      GO TO 340
C
C         INITIALIZE MICROFILM HERE
C
```

```
C
 330  CONTINUE
C
C
C
 340  CONTINUE
      IF(IOPT .GT. 3) GO TO 20
      GO TO(5,10,20),IOPT
   5  CONTINUE
C
C      PLOT REFERENCE PLOTS
C
C      TIME VS ALTITUDE
C
C
      CALL HNDYLO(IHCOPY,TZ,ZZ,NT,1,1)
      CALL ENDPL(0)
C
C
C         TIME VS VELOCITY
C
      CALL HNDYLO(IHCOPY,TZ,UZ,NT,2,1)
      CALL ENDPL(0)
C
C        TIME VS ANGLE OF ATTACK
C
C       IF(ALFA0T .LE. 0) GO TO  10
C
      CALL HNDYLO(IHCOPY,TZ,ALFA0T,NT,3,1)
      GO TO 40
C
C
C      TIME VS QDOT REF
C
  10  CONTINUE
      CALL DSMMLO(IT,QC1T,YMIN,YMAX)
      CALL AXSPLT(0.0,YMAX,6.0,YOR,YSTEP,YAXIS)
      CALL PPLOT1(11,ICASE)
C     CALL BLNK1(0.0,2.5,5.0,6.2,3)
      CALL DRAWLO(XOR,XSTEP,XAXIS,YOR,YSTEP,YAXIS,TIME1,QC1,IT,3,3,
     1 IHCOPY)
      CALL DRAWLO(XOR,XSTEP,XAXIS,YOR,YSTEP,YAXIS,TIME1,QC1T,IT,2,3,
     1 IHCOPY)
      CALL LINES('(T)U (R)AD (E)Q (T)EMP.S',IPAK,1)
      CALL LINES('(T)U      (D)EG. (F)S',IPAK,2)
      IPT=-1
      CALL LEGEND(IPAK,2,2.5,6.2)
      CALL INTNO(ITINIT,3.4,6.2)
      IF(IHCOPY .LE. 0) GO TO 99
      GO TO 902
  99  CONTINUE
      CALL ENDPL(0)
      READ(5,901)
 901  FORMAT( )
      CALL ERASE
      GO TO 40
C
```

```
 116:  900  CONTINUE
 117:       CALL ENDPL(0)
 118:       CALL HDCOPY
 119:       CALL ERASE
 120:       GO TO 40
 121:C
 122:C
 123:   20  CONTINUE
 124:       GO TO(25,30,110,120,130,140,150,160,170),IOPT1
 125:  110  CONTINUE
 126:       CALL HNDYLO(IHCOPY,TIME1,AKLZ1,IT,4,3)
 127:       GO TO 40
 128:  120  CONTINUE
 129:       CALL HNDYLO(IHCOPY,TIME1,HFACZ1,IT,5,3)
 130:       GO TO 40
 131:  130  CONTINUE
 132:       CALL HNDYLO(IHCOPY,TIME1,XME1,IT,6,3)
 133:       GO TO 40
 134:  140  CONTINUE
 135:       CALL HNDYLO(IHCOPY,TIME1,REL1,IT,7,3)
 136:       GO TO 40
 137:  150  CONTINUE
 138:       CALL HNDYLO(IHCOPY,TIME1,HFACZ1,IT,8,3)
 139:       GO TO 40
 140:  160  CONTINUE
 141:       CALL HNDYLO(IHCOPY,TIME1,PE1,IT,9,3)
 142:       GO TO 40
 143:  170  CONTINUE
 144:       CALL HNDYLO(IHCOPY,TIME1,DELTAT,IT,13,3)
 145:       GO TO 40
 146:C
 147:C
 148:   25  CONTINUE
 149:C
 150:C
 151:C       LONG PLOT
 152:C
 153:C       LAMINAR FACTORS
 154:C
 155:C
 156:C       LAMINAR FACTORS
 157:C
 158:       CALL HNDYLO(IHCOPY,TIME1,AKLZ1,IT,4,3)
 159:C
 160:       IF(ARIDEF .NE. 1) GO TO 26
 161:C
 162:C       DEFLECTION FACTORS
 163:C
 164:       CALL HNDYLO(IHCOPY,TIME1,HFACZ1,IT,5,3)
 165:C
 166:C
 167:   26  CONTINUE
 168:C
 169:C       LOCAL MACH NUMBER
 170:C
 171:       CALL HNDYLO(IHCOPY,TIME1,XME1,IT,6,3)
 172:C
 173:C
```

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174:       IF(MMFLAG .EQ. 1) GO TO 27
175:C
176:C       REYNOLDS NUMBER LOCAL/1.0E6
177:C
178:       CALL MMDYLO(IHCOPY,TIME1,REL1,IT,7,3)
179:C
180:C
181:       GO TO 28
182:C
183:    27  CONTINUE
184:C
185:C
186:C            REFAC
187:C
188:       CALL MMDYLO(IHCOPY,TIME1,HFACZ1,IT,8,3)
189:C
190:    28   CONTINUE
191:C
192:C       LOCAL  PRESSURE   LBF/FT-SQ
193:C
194:       CALL MMDYLO(IHCOPY,TIME1,PE1,IT,9,3)
195:C
196:C
197:C        C SUB P
198:C
199:       CALL MMDYLO(IHCOPY,TIME1,CP1,IT,10,3)
200:C
201:C       SHORT PLOTS
202:C
203:   30   CONTINUE
204:C
205:C
206:       IF(ARIDEF .NE. 1 ) GO TO 210
207:C
208:C       CONTROL SURFACE DEFLECTION PLOT
209:C
210:C       CALL MMDYLO(IHCOPY,TIME1,DELTAT,IT,13,3)
211:C
212:  210  CONTINUE
213:C
214:C       Q  DOT (BTU/FT-SQ-SEC) PLOT
215:C
216:       CALL MMDYLO(IHCOPY,TIME1,QC1,IT,11,3)
217:C
218:C        TITLE TWAL (DEG F) PLOT
219:C
220:       CALL DSMMLO(IT,TREF1,YMIN,YMAX)
221:       CALL DSMMLO(IT,TW1,YMIN1,YMAX1)
222:       YMIN=AMIN1(YMIN,YMIN1)
223:       YMAX=AMAX1(YMAX,YMAX1)
224:       CALL AXSPLT(0.0,YMAX,6.0,YOR,YSTEP,YAXIS)
225:       CALL PPLOT1(12,ICASE)
226:       CALL DRAWLO(XOR,XSTEP,XAXIS,YOR,YSTEP,YAXIS,TIME1,TREF1,IT,3,3,
227:      1 IHCOPY)
228:       IF(ATRE .GT. 0.001) GO TO 236
229:       CALL DRAWLO(XOR,XSTEP,XAXIS,YOR,YSTEP,YAXIS,TIME1,TW2,IT,2,3,
230:      1 IHCOPY)
231:  236  CONTINUE
```

```
      IF(IHCOPY .LE. 0) GO TO 237
      GO TO 238
  237 CONTINUE
      CALL ENDPL(0)
      READ(5,901)
      CALL ERASE
      GO TO 239
  238 CONTINUE
      CALL HDCOPY
      CALL ERASE
C
  239 CONTINUE
      IF(ITHICK .NE. 0) GO TO 37
       GO TO 40
C
   37 CONTINUE
C
C      TWALL (DEG F) PLOT TW2
C
      CALL HNDYLO(IHCOPY,TIME1,TW2,IT,12,3)
C
   40 CONTINUE
      RETURN
      END
```

11. SUBROUTINES USED BY MINIVER

Routine name	Symbolics available	Source system or library
H800	Yes	MINIVER
AXSPLT	No	DISSPLA
AIR62	Yes	MINIVER
ATMS4	Yes	MINIVER
BASALF	No	DISSPLA
NINTRP	Yes	MINIVER
CHEEVY	Yes	MINIVER
CRSFLW	Yes	MINIVER
CURVE	No	DISSPLA
DETRAL	Yes	MINIVER
DINT	Yes	MINIVER
DINT1	Yes	MINIVER
DOWNID	Yes	MINIVER
DRAWLO	Yes	MINIVER
DRIVEL	Yes	MINIVER
DSMMLO	Yes	MINIVER
EDPARM	Yes	MINIVER
ENDPL	No	DISSPLA
ERASE	No	PLOT10,LOCALIB
ERTRAN	No	LOCALIB
FINALT	Yes	MINIVER
FAYRID	Yes	MINIVER
FLOW	Yes	MINIVER
GAUSS	Yes	MINIVER
GRACE	No	DISSPLA
GRAPH	No	DISSPLA
GRID	No	DISSPLA
HANSEN	Yes	MINIVER
HDCOPY	No	PLOT10,LOCALIB
HNDYLO	Yes	MINIVER

Routine name	Symbolics available	Source system or library
HEIGHT	No	DISSPLA
INTNO	No	DISSPLA
IOWAIT	No	PLOT10,LOCALIB
LEGEND	No	DISSPLA
LINES	No	DISSPLA
MATRES	Yes	MINIVER
MESSAG	No	DISSPLA
MIXALF	No	DISSPLA
MOLIER	Yes	MINIVER
NEWOUT	Yes	MINIVER
NEWT	Yes	MINIVER
NOCHEK	No	DISSPLA
OPTMYZ	Yes	MINIVER
PCSW	Yes	MINIVER
PLOT10	Yes	MINIVER
PMEXPN	Yes	MINIVER
PM10	Yes	MINIVER
PPLOT1	Yes	MINIVER
PRINT1	Yes	MINIVER
RADEQ	Yes	MINIVER
SETMUP	Yes	MINIVER
STABLE	Yes	MINIVER
STOCK	Yes	MINIVER
STORED	Yes	MINIVER
SWCYL2	Yes	MINIVER
TBLIN	Yes	MINIVER
TEKEGM	No	DISSPLA
TINT6	Yes	MINIVER
TRANS	Yes	MINIVER
VRUNL	Yes	MINIVER
WRINP	Yes	MINIVER
XINTAX	No	DISSPLA
YAXANG	No	DISSPLA
YINTAX	No	DISSPLA

12. REFERENCES

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2. DISSPLA Beginners Manual. Integrated Software System Corporation; July 1975.

3. DISSPLA Intermediate Manual. Integrated Software System Corporation; July 1975.